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Medical Waste Incinerators - Background Information for Proposed Standards and Guidelines:

Regulatory Impact Analysis for New and Existing Facilities

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EXECUTIVE SUMMARY

This report has been prepared to comply with Executive Order 12866, which requires federal agencies to assess costs and benefits of each significant rule they propose or promulgate. The proposed regulation of medical waste incinerators meets the Order's definition of an economically significant rule. The Agency has attempted to assess both the costs and benefits of the proposed rule, as presented in this Regulatory Impact Analysis (RIA).

An estimated 3.4 million tons of medical waste are produced annually by medical waste generators. These generators include facilities such as hospitals, veterinary clinics, nursing homes, dentists' offices, etc. Waste categorized as medical waste include items such as needles and other sharp medical objects, fabrics and garments, plastics, paper, waste chemicals, and pathological waste. Generators of the above items either burn the items in an on-site incinerator or ship the waste to either other facilities that operate an incinerator or to a commercial medical waste incinerator (MWI). Air emissions resulting from the operation of MWIs include furans and dioxins (CDD/CDF), hazardous air pollutants (HAPs) such as lead, cadmium, mercury and hydrochloric aced and criteria pollutants such as sulfur dioxide, nitrogen oxide, particulate matter, and carbon dioxide.

This document examines the impact of imposing both the Emission Guidelines (EG), aimed at controlling emissions from existing MWIs, and the New Source Performance Standards (NSPS), aimed at controlling emissions from new MWIs. The EG is expected to affect an estimated 3,700 existing MWIs. [note: Although approximately 5,000 MWIs are believed to exist nationwide, 1,300 of these MWIs exclusively burn pathological waste. These pathological MWIs are excluded from this regulation. However, some of the analyses presented in this document were completed before the decision was made to exclude the pathological MWIs. The exclusion of these pathological incinerators is not expected to significantly affect the impact estimates because the amount of pathological medical waste generated as a proportion of total medical waste is relatively small.]

The annualized control costs for controlling the existing MWIs is estimated to be approximately $1.4 billion (1989 $). Using this cost, the economic impact analysis estimates that the overall impact on the prices of services generating medical waste (i.e., hospital services, nursing home care, etc.) is relatively small (less than two percent price increase for any final product). The lack of significant price impacts, despite the magnitude of the annualized cost, may be due to one of two reasons. One explanation for the low impacts may be that the costs are spread over a substantial amount of revenue . In general, medical waste incineration is only a small cost of a typical facility's total operating budget. A second reason for the small impacts may be the possibility of substitution to lower cost alternatives as opposed to onsite incineration (i.e., onsite autoclaving or contract disposal). The combination of these two factors leads to the conclusion that significant economic impacts should not result from implementation of the proposed rules.

The annualized control costs for controlling new MWIs is approximately $277 million (1989 $). The economic impact analysis for new sources estimates that this cost increase will result in relatively impacts on the prices of services generating medical waste (less than 2% for any final product). Reasons for the lack of significant price impacts for new sources are similar to those for existing sources, as explained above.

The benefits of implementing the proposed regulations is expected to result from reducing CDD/CDF, HAP, and criteria pollutant emissions. The EG is expected to reduce annual HAP emissions by approximately 40,000 Mg and annual CDD/CDF emissions by approximately 285 Kg. The NSPS is expected to reduce annual HAP emissions by approximately 10,000 Mg and annual CDD/CDF emissions by approximately 22 Kg. Due to lack of data, the benefits of reducing HAP emissions is only discussed in a qualitative manner. These benefits are discussed in terms of reducing adverse human health effects. In addition, the EG is expected to reduce annual criteria pollutant emissions by approximately 24,000 Mg. The NSPS is expected to reduce annual criteria pollutant emissions by approximately 3,000 Mg. The benefits of reducing criteria pollutant emissions are discussed in terms of reducing adverse human health effects as well as adverse welfare effects. Where possible, the benefits analysis has attempted to quantify the benefits of reducing these emissions. For the EG, the analysis estimates that quantified particulate matter benefits are approximately $37.5 million/yr. (1989 $) In addition, the analysis estimates that quantified particulate matter benefits associated with the NSPS are approximately $5.4 million/yr. (1989 $)

1.0 INTRODUCTION

1.1 Purpose

This report has been prepared to comply with Executive Order 12866, which requires federal agencies to assess costs and benefits of each significant rule they propose or promulgate. The proposed regulation of medical waste incinerators meets the Order's definition of a significant rule. The Agency has assessed both the costs and benefits of the proposed rule, as presented in this Regulatory Impact Analysis (RIA).

1.2 Organization of the Report

The principal requirements of the Executive Order are that the Agency perform an analysis comparing the benefits of the regulation to the costs that the regulation imposes, that the Agency analyze alternative approaches in the development of the rule, and that the need for the regulation be identified. Wherever possible, the costs and benefits of the rule are to be expressed in monetary terms. To address the analytical requirements of the Executive Order, this RIA is organized as follows:

Chapter 2 presents an overview of the legislative, regulatory, and policy background for the proposed regulations. This chapter also provides an overview of the medical waste incineration industry.

Chapter 3 briefly explains market failures that environmental pollution control regulations are intended to correct. In addition, this section discusses the environmental factors necessitating the development of the proposed regulation. Finally, the Agency's legal mandate for developing the regulation is summarized.

Chapter 4 describes the regulatory requirements associated with the Emission Guidelines as well as the requirements of the New Source Performance Standards.

Chapter 5 presents a summary of the estimated annual costs of compliance associated with the proposed regulations.

Chapter 6 describes the types of industries that generate medical waste and therefore, will be affected by the proposed rules.

Chapter 7 presents a summary of the economic impacts associated with the proposed rules.

Chapter 8 discusses the health and environmental benefits expected to result from implementation of the proposed regulation. Relevant benefit categories are presented in a qualitative discussion, and where possible, an attempt is made to quantify these benefits.

Chapter 9 provides a partial comparison of the costs and benefits of the proposed rules. A direct comparison of costs and benefits is not possible since it was not possible to quantify most of the benefit categories.

2.0 BACKGROUND

2.1 Regulatory Background

Medical waste incinerators are subject to State and local regulations that vary widely both in format and in scope. A survey in April 1990 showed that in 38 states, regulations or permit guidelines specific to MWIs were either in place or were in the planning stages. The remainder of the States regulate MWIs under general incinerator requirements, which typically are less stringent than those specific to MWIs. The most common State requirements for MWIs are limits for particulate matter (PM), hydrogen chloride (HCl), and secondary chamber temperature and residence time. Some States also regulate metals, dioxins and furans (CDD/CDF), and carbon monoxide (CO). About half the States with requirements specific to MWIs require operator training or certification.

On November 1, 1988, the Medical Waste Tracking Act (MWTA) was signed. The MWTA required the EPA to establish a 2-year demonstration program to track medical waste from its origin to its disposal. In early 1989, the EPA established this program in 40 CFR Part 259. The program was in effect from June 22, 1989, to June 22, 1991 and applied to the states of New York, New Jersey, Connecticut, and Rhode Island and to Puerto Rico. The MWTA required the EPA to prepare a series of Reports to Congress on medical waste and the demonstration program. Now that the demonstration program has concluded, Congress will decide if a medical waste tracking program should be implemented nationwide.

Section 129 of the CAA specifically addresses development of standards for MWIs. Section 129 requires the EPA to establish an NSPS for new MWIs and EG for existing MWIs that combust hospital waste, medical waste, and infectious waste. The standards and guidelines must specify numerical emissions limitations for the following: PM, opacity, sulfur dioxide (SO_2), HCl, nitrogen oxides (NO_x), CO, lead (Pb), cadmium (Cd), mercury (Hg), and CDD/CDFs. Section 129 also includes requirements for operator training and certification as well as siting requirements for new MWIs. Section 129 directs that standards and guidelines are to be promulgated no later than November 15, 1992.

The current air emissions standards development effort for MWIs was initiated in 1989. The data gathering effort was designed to take advantage of information gathered under the auspices of the MWTA. Also, in 1989, an MWI operator training course and manual were developed with recommendations on the proper operation of MWIs.

2.2 Medical Waste Industry Characteristics

The Solid Waste Disposal Act defines medical waste as "...any solid waste which is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in production or testing of biologicals." In addition, for the purpose of developing air emission standards for MWIs, medical waste also includes: waste generated by health care providers who provide medical services to individuals in private homes when the waste is removed from the home and transported to the provider's place of business for disposal; and veterinary waste that is generated at a home or farm when the waste is transported to the veterinarian's place of business.

An estimated 3.4 million tons of waste are produced annually by medical waste generators in the United States. Table 2-1 presents the estimated number of facilities and the quantity of waste generated annually by generator category. Hospitals are the single largest generator of medical waste, producing over 70 percent of the annual total.

Approximately 5,000 MWIs are believed to exist. Table 2-2 presents the estimated number of MWIs and percent of the total population by facility type. Over 60 percent of these MWIs are found at hospitals. [note: This analysis was completed before a decision was made to exclude pathological MWIs from the proposed rules. An estimated 3,700 MWIs burning mixed medical waste are currently covered under the proposed rules. The exclusion of approximately 1,300 MWIs exclusively burning pathological waste is not expected to significantly affect the impact estimates because the amount of pathological waste burned at these facilities is a relatively small proportion of the total amount of medical waste incinerated annually.]

Medical waste consists of the following types of materials:

1. Sharps (e.g., hypodermic and suture needles, scalpel blades, syringes, pipettes, vials, other types of broken or unbroken glassware, etc.);
2. Fabrics (e.g., gauze, garments, swabs, etc.);
3. Plastics (e.g., trash bags, sharps containers, IV bags, tubes, specimen cups, etc.);
4. Paper (e.g., disposable gowns, sheets, etc., premoistened towels, paper towels, etc.);
5. Waste chemicals/drugs (e.g., lab chemicals, left-over and out-of-date drugs, disinfectants,etc.);
6. Pathological waste (e.g., human and animal body parts and tissue).

Most of these materials burn readily and, given the proper conditions, will continue to burn once they are ignited. Metal and glass sharps do not burn but also do not greatly impede

Table 2-1. Estimated Number of U.S. Facilities and Quantity of Waste Generated Annually by Generator Category

Generator Category	No. of Facilities	Annual Total Waste Generated (tons)
Hospitals	7,000	2,400,000
Physicians' Offices	180,000	235,000
Long-Term Care Facilities (nursing homes)	42,000	207,000
Clinics (outpatient care)	41,300	175,000
Laboratories (medical/research)	7,200	173,000
Dentists' Offices	98,000	58,000
Free-Standing Blood Banks	900	33,000
Veterinarians	38,000	31,000
Corrections	4,300	22,000
Fire and Rescue	7,200	11,000
Health Units in Industry	221,700	9,000
Funeral Homes	21,000	6,000
Police	13,100	<1,000
TOTAL	682,400	3,361,000

Table 2-2. Estimated U.S. MWI Population

Facility Type	Population	
	Units	Percent of Total
Hospitals	3,150	63
Veterinary Facilities	550	11
Nursing Homes	500	10
Laboratories	500	10
Commercial Facilities	150	3
Other/Unidentified Facilities	150	3
TOTAL	5,000	100

combustion of other materials. Pathological waste has a very high moisture content and will not support self-sustained combustion but will burn if adequate heat is applied to drive off the moisture.

Most MWIs burn a diverse mixture of medical waste, which my include a small percentage of pathological waste (one manufacturer specifies up to 5 percent). Larger amounts of pathological waste require special operating conditions for combustion; thus, some facilities maintain MWIs designed and operated to burn pathological waste exclusively.

Because of differences in waste composition and the combustion process, uncontrolled emissions from mixed medical waste incinerators and pathological incinerators are very different. Mixed medical waste typically contains more metals and chlorine than does pathological waste, resulting in higher emissions of metals and HCl from mixed medical waste incinerators than from pathological incinerators. Mixed medical waste incinerators also have higher emission rates of PM, CO, and CDD/CDF than do pathological incinerators. Because of the difference in the nature of the waste burned, pathological MWIs and mixed medical waste MWIs are considered two distinct subcategories for the purpose of regulatory development.

2.3 Types of Medical Incinerator Design

The three different design types of MWIs are continuous units, intermittent units, and batch units. In each of these systems, sequential combustion operations typically are carried out in two separate chambers, primary and secondary. In the primary chamber, the waste is loaded and ignited, the volatile components driven off, and the nonvolatile materials combusted to ash. The volatile components, such as organics, that are released from the primary chamber are combusted in the secondary chamber. New MWIs are typically designed with 1-sec residence time secondary chambers; older MWIs were designed with smaller, .25-sec residence time secondary chambers.

All MWI capacities shown in this section are based on the assumption that the heating values of mixed medical waste and pathological waste are 8,500 British thermal units per pound (Btu/lb) and 1,000 Btu/lb, respectively.

While there are similarities in the three design types of MWIs, as mentioned above, there are also key differences that make each type unique. The primary difference between the three design types of MWIs is the operating cycle. This difference causes a variation in the way the waste is burned and in the pollutant emission profile for each MWI design type. The method of charging the waste into the primary chamber and of removing ash from the primary chamber dictates the MWI operating cycle.

Continuous units, which are the largest of the three types, have mechanical ram feeders and continuous ash removal systems. These features allow the unit to operate 24 hours per day for many days at a time. Continuous MWIs achieve steady-state operation in the beginning of their operating cycle and maintain this mode of operation throughout the remainder of the cycle. Waste is charged and ah is removed simultaneously. During this period, waste is burned at the same rate as it is charged into the unit and pollutant emission rates and primary and secondary chamber temperatures tend to be relatively constant.

Most intermittent MWIs also have mechanical ram feeders that charge waste into the primary chamber at about 5 to 10 minute intervals. However, there is no means for ash removal during the burning cycle, the unit can only be operated for a limited number of hours before the accumulation of ash in the primary chamber becomes a problem. intermittent units, which are usually much smaller than continuous units, typically operate on a daily burn cycle. While these units tend to approach steady-state operation during the middle of their operating cycle, waste is normally being charged faster than it is being burned. Primary chamber temperatures tend to climb throughout the operating cycle until waste is no longer charged into the unit. Because there is a significant amount of unburned material in the primary chamber at the end of the charging period, these units are designed with a burndown/cooldown phase. Generally, pollutant emissions continue throughout this phase, which can proceed for several hours beyond charging.

The batch operating cycle consists of three phases- burn (low-air), burndown (high-air), and cooldown. All of the waste to be burned during a complete cycle is loaded into the primary chamber before the unit begins operation. Once the unit is filled with waste and the burning cycle begins, the charging door is not opened again until the cycle is complete and the unit is cool. This cycle normally takes 1 or 2 days depending on the size of the unit and the amount of waste charged. During the burn phase, temperatures in the primary chamber rise slowly because combustion is occurring only on the surface of the waste pile and because combustion air is restricted. When the burndown phase begins, the temperatures climb more rapidly, more volatiles are exposed to the flame front, and the combustion process quickens. Batch MWIs tend to approach steady state operation at the end of the burn phase, when the primary chamber temperature reaches the design operating range. Pollutant emission rates also tend to increase in the second half of the burn phase, then level off, and continue steadily during the burndown and cooldown phases. pollutant concentrations during burndown in batch MWIs are similar to concentrations during charging in continuous and intermittent units.

Medical waste incinerators are divided into four subcategories for the purpose of regulatory development. These subcategories are based on the two waste types discussed in Section 3.2 (mixed medical waste and pathological waste) and on the three MWI design types discussed in this section. Mixed medical waste is burned in all 3 MWI design types resulting in 3 distinct subcategories: continuous, intermittent, and batch MWIs. However, pathological waste is burned almost exclusively in intermittent MWIs resulting in one additional subcategory: pathological MWIs.

2.4 Model Combustors

Based on historic sales data, an estimated 700 new MWIs will be installed over the next 5 years. The majority of these units will burn mixed medical waste. Future MWIs are expected to be comprised of 55 percent intermittent units, 25 percent batch units, 20 percent continuous units, and less than 1 percent pathological units. An estimated 5,000 existing MWIs will potentially be subject to the EG. Based on information from incinerator manufacturers, hospitals, and State surveys, the existing population of MWIs is comprised of approximately 60 percent intermittent units, 26 percent pathological units, 7 percent continuous units, and 7 percent batch units.

The population distribution projected for new units differs substantially from the estimated distribution of existing units. The distribution of new units is estimated based on known MWIs of all ages. The projected increase in the percentage of continuous MWIs burning mixed medical waste is primarily related to the increasing number of commercial MWI facilities.

Seven different model combustors were selected to represent new and existing MWI facilities: two continuous, three intermittent, one batch, and one pathological unit. These model combustors were selected to represent each common type of combustor design, and typical sizes were selected within each combustor design type. Table 2-3 lists the model design capacity, the design operating parameters, and the applicable industries for each model combustor.

Table 2-3. Summary of Model Combustors

Combustor Type	Model Design Capacity (lb/d)	Design Operating Parameters		No. of Existing Units	Projected No. of New Units	Applicable Industries
		hr/d	d/yr			
Continuous	36,000	24	324	154	77	Commercial Facilities
Continuous	24,000	24	324	182	60	Hospitals, Laboratories
Intermittent	21,000	14	312	171	20	Hospitals, Nursing Homes, Laboratories
Intermittent	8,400	14	312	742	95	Hospitals, Nursing Homes, Laboratories
Intermittent	2,000	10	312	2,097	280	Hospitals, nursing Homes, Laboratories, Veterinary Clinics
Batch	250	12[a]	170	335	165	Hospitals
Pathological	2,000	10	312	1,305	5	Hospitals, Nursing Homes, Laboratories, Veterinary Clinics

a. This unit operates on a 2-day cycle. Includes burning and burndown hour. Cooldown is 10hr/d.

3.0 NEED FOR THE REGULATION

The Executive Order requires that the Agency identify the need for the regulation being proposed. The emission of air pollutants poses a threat to human health and the environment. Risks from these emissions include increases in cancer risk, other adverse cancer risk, and degradation of the environment. This section will discuss: (1) the reasons the marketplace does not provide for adequate pollution control absent appropriate incentives or standards; (2) the environmental factors that indicate the need for additional pollution controls for this source category; and (3) the legal requirements that dictate the necessity for and timing of this regulation.

3.1 Market Failures

The need for emission limitations for this source category arises from the failure of the marketplace to provide the optimal level of pollution control desired by society. Corrections of such a market failure may require federal regulation. Examples of market failures are situations where externalities, natural monopolies, or inadequate information may exist. This section addresses the category of externalities, the category of market failure most relevant to the general case of environmental pollution.

The concept of externalities partially explains the discrepancy between the supply of pollution control provided by owners and operators of pollution sources and the level of environmental quality desired by the general population. The case of environmental pollution can be classified as a negative externality because it is an unintended by-product of production that creates undesirable effects on human health and the environment.

In making production decisions, owners and operators will only consider those costs and benefits that accrue to them personally, i.e., internalized costs and benefits. However, the cost of environmental pollution is not borne solely by the creators of the pollution because all individuals in the polluted area must share the social cost of exposure to the pollution, even if they had no part in creating the pollution. Therefore, although owners and operators may be the creators of pollution, they do not necessarily bear the costs of the pollution. Government regulation is an attempt to internalize the costs of pollution.

If the people affected by a particular pollution source could negotiate with the party responsible for that source, the parties could negotiate among themselves to reach an economically efficient solution. The solution would be efficient because it would involve trading of pollution and compensation among the owner or operator and the people affected by the pollution.

Individual negotiation often does not occur in an unregulated market, however, because of high transactions costs, even if trade among the affected parties would be beneficial to all parties involved. For the majority of environmental pollution cases, the costs of identifying all the affected individuals and negotiating and agreement among those individuals are prohibitively high. Another problem preventing negotiations from taking place is that our current market system does not clearly define liability for the effects of pollution.

In the case of environmental quality, an additional problem is the public nature of this "good." Environmental quality is a public good because it is predominantly nonexcludable and nonrival. Individuals who willingly pay for reduced pollution cannot exclude others who have not paid from also enjoying the benefits of a less polluted environment. Because many environmental amenities are nonexcludable, individuals utilize but do not assume ownership of these goods, and therefore, will not invest adequate resources in their protection. The result is that in the absence of government intervention, the free market will not provide public goods, such as clean air, at the optimal quantity and quality desired by the general public.

3.2 Environmental Factors

In the case of medical waste incineration, the result of the market's failure to promote air pollution control is that pollution of the nation's air is not controlled to the optimal level. This operation of MWIs releases HAPs, dioxins and furans, and criteria pollutants into the ambient air. Chapter 8 discusses in detail the air quality impacts of the proposed regulation.

The EG are expected to decrease annual emissions of: air toxics by approximately 40,000 Mg, dioxins and furans by approximately 285 Kg, and criteria pollutants by approximately 24,000 Mg . Additionally, the NSPS are expected to decrease annual emissions of: air toxics by approximately 10,000 Mg, dioxins and furans by approximately 22 Kg, and criteria pollutants by approximately 3,000 Mg.

3.3 Legal Requirements

These Maximum Available Control Techonology (MACT) emission standards and guidelines are proposed under the authority of Section 129 of the Clean Air Act as amended in 1990.

4.0 REGULATORY REQUIREMENTS

4.1 INTRODUCTION

In this chapter, the major industries in which medical waste is generated are identified and characterized. For each industry, such information as the number of facilities, the amount of waste generated, and the number and distribution of MWIs, is presented. Please refer to either the "Analysis of Economic Impacts for New Sources" or the "Analysis of Economic Impacts for Existing Sources" for sources of the estimates of the number of facilities. Derivations of the estimates of the amount of waste generated and the number of MWIs can be found in the "Industry Profile Report for New and Existing Facilities."

[note: This analysis was completed before a decision was made to exclude pathological MWIs from the proposed rules. Therefore, total MWI population figures as well as the allocation of MWIs to the appropriate medical waste generator industries the inclusion of approximately 1,300 pathological incinerators. The exclusion of the pathological MWIs is not expected to significantly affect the impact estimates that are presented here because the amount of pathological waste generated as a proportion of the total medical waste generated is relatively small.]

4.2 WASTE GENERATED

For the major industries in which medical waste is generated, the number of facilities and estimated total waste generated are provided in Table 4-1. "Total" waste includes medical waste and any other solid waste generated. Therefore, general refuse is included. Total waste was calculated from the estimated amount of infectious waste generated, assuming that infectious waste comprises 15 percent of total waste. This is based on a national survey indicating that a median of 15 percent of total waste at hospitals is infectious. This relationship at hospitals is assumed to apply to all other industries generating medical waste.

The majority of medical waste is generated by industries involved in the provision of health care. Table 4-1 shows that among medical waste generators, hospitals generate by far the most total waste. Hospitals account for 2.4 million, or 71 percent, of the estimated 3,361,000 tons of total waste generated annually by medical waste generators. This comes to 348.7 tons per hospital. The next-biggest waste generators are physicians' offices, nursing homes, outpatient care facilities, and medical and dental labs. On a per-facility basis, however, freestanding blood banks, at 151.4 tons per year, are second to hospitals.

TABLE 4-1. TOTAL WASTE GENERATED, BY INDUSTRY

Industry	Number of facilities	Total waste generated (tons/yr) Industry-wide	Total waste generated (tons/yr) Average per facility
Hospitals	6,882	2,400,000	348.7
Nursing homes	17,525	198,000	11.3
Veterinary facilities	21,496	31,000	1.4
Laboratories			
Research	3,826[a]	55,500	<14.5
Other		117,500	7.9
Medical	6,871		
Dental	7,970		
Funeral homes	22,000	6,000	0.3
Physicians' offices	191,278	235,000	1.2
Dentists' offices and clinics	104,213	58,000	0.6
Outpatient care		175,000	<23.8
Physicians' clinics	6,519		
Freestanding kidney dialysis facilities	839		
Other[b]	N/A		
Freestanding blood banks	218[c]	33,000	151.4
Fire and rescue operations	29,840	11,000	0.4
Correctional facilities	4,288	22,000	5.1
Other[d]	258,700	19,000	0.1
TOTAL	>682,465	3,361,000	

[a]Commercial facilities only. Does not include captive research labs.
[b]Home health care agencies, hospices, drug treatment centers, et al.
[c]164 members of the American Association of Blood Banks, one facility that is not a member, and 53 regional Red Cross centers.
[d]Includes health units in industry, residential care facilities, and police departments.
N/A Not available.

This results, though, from treating each member of the American Association of Blood Banks and each regional Red Cross center as only one facility.

All industries in Table 4-1 are included in the economic impact analysis (see Chapter 7) with the exception of the industries represented by the two "other" groupings. The first, a subset of outpatient care, includes such outpatient health care providers as home health care agencies, hospices, and drug treatment centers. On average, the "other" outpatient care facilities generate less medical waste than physicians' clinics (i.e., ambulatory care centers — both general and surgical) and freestanding kidney dialysis facilities. Therefore, it is assumed that their economic impacts are conservatively represented by the impacts calculated for physicians' clinics and freestanding kidney dialysis facilities.

The second "other" grouping includes health units in industry, residential care facilities, and police departments. Health units in industry and police departments are excluded from the economic impact analysis because they generate very little waste (per facility, on average only 0.04 tons/year and 0.08 tons/year, respectively) and therefore are likely to be minimally impacted by the NSPS and Emission Guidelines. Although residential care facilities — which are similar to, but offer less comprehensive services than, nursing homes — generate on average 0.38 tons per year of waste, they are excluded from the economic impact analysis because their impacts are conservatively represented by nursing homes, which generate more waste.

4.3 EXISTING MWI AND NEW MWI POPULATIONS

4.3.1 Existing MWIs

About 5,000 MWIs are believed to exist in the U.S. They are operated primarily by hospitals, nursing homes, veterinary facilities (including animal hospitals), research labs, and commercial incineration facilities. Using primarily data from state air programs and state hospital associations, the number of existing MWIs in each of these industries was estimated by extrapolating nationwide based on population. As represented by the "projected nationwide population" in Table 4-2, it is estimated that there are 3,150 existing MWIs at hospitals, 500 at nursing homes, 550 at veterinary facilities, 500 at research labs, and 150 at commercial incineration facilities. In addition, 136 existing MWIs have been attributed to other/unidentified industries. This category includes the few outpatient clinics, blood banks, etc. that operate an MWI but are not common enough to justify separate industry categories, as well as MWIs that were identified in the state data but could not be attributed to any industry.

TABLE 4-2. DISTRIBUTION OF EXISTING MWIs

Industry	Model MWI[a]		Adjusted capacity per MWI (tons/yr)[b]	Identified population	Projected nationwide population
Hospitals	Inter.	21,000	1,176	50	142
	Cont.	24,000	977	57	161
	Inter.	8,400	470	219	620
	Path.	2,000	172	158	448
	Inter.	2,000	115	513	1,453
	Batch	250	27	115	326
					3,150
Nursing homes	Inter.	8,400	470	2	19
	Path.	2,000	172	14	132
	Inter.	2,000	115	37	349
					500
Veterinary facilities	Path.	2,000	172	86	493
	Inter.	2,000	115	10	57
					550
Research labs	Inter.	21,000	1,176	6	23
	Cont.	24,000	977	4	16
	Inter.	8,400	470	21	83
	Path.	2,000	172	50	197
	Inter.	2,000	115	46	181
					500
Commercial incineration facilities	Cont.	36,000	3,907	39	150
Other/ unidentified	Cont.	36,000	3,907		4
	Inter.	21,000	1,176		5
	Cont.	24,000	977		5
	Inter.	8,400	470		20
	Path.	2,000	172		36
	Inter.	2,000	115		57
	Batch	250	27		9
					136
TOTAL					4,986

[a]Inter. = Intermittent, Cont. = Continuous, Path. = Pathological.

[b]Intermittent and Continuous MWIs: lb/hr design capacity x 67% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Pathological MWI: lb/hr design capacity x 100% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Batch MWI: lb/batch design capacity x 67% x batches/yr x 1/2,000 tons/lb.

In addition to the 4,986 existing MWIs represented in Table 4-2, there are also some municipal waste combustors (MWCs) that co-fire medical waste. Thirty-one such MWCs were identified but there is no basis for extrapolating beyond these units. These MWCs are not included in Table 4-2 because medical waste typically accounts for only a small portion of their total waste stream. They are also not included in the economic impact analysis because their impacts are likely to be conservatively represented by commercial medical waste incineration facilities.

Table 4-2 also shows the distribution of existing MWIs as represented by the seven model MWIs developed in Section 4.1 of the "Model Plant Description and Cost Report." The model MWIs are identified in Table 4-2 by type and lb/day design capacity (e.g., the Continuous 36,000 is a continuous-duty MWI with a daily design capacity of 36,000 pounds).

The "identified population" distribution in Table 4-2 represents MWIs that were specifically identified from information provided by MWI manufacturers, information requests to hospitals and commercial incineration facilities, state surveys, and emissions test reports. Identified MWIs were assigned to the most representative model MWI. The nationwide distribution of MWIs ("projected nationwide population" in Table 4-2) was then derived within each industry by using the same proportions as in the identified population and by constraining the sum to equal the industry total (e.g., 3,150 for hospitals).

4.3.2 <u>New MWIs</u>

The NSPS applies to new MWIs, defined to include newly built, modified, and reconstructed units. The projected distribution of new MWI sales (newly built MWIs) in the five-year period following adoption of the NSPS and EG is shown in Table 4-3. The total, 702, as well as the distribution, are extrapolated from the 1985-1989 sales of seven vendors believed to represent about two-thirds of the MWI market.

The distribution is represented by the seven models developed for new MWIs in Section 2.1 of the "Model Plant Description and Cost Report." With the exception of the Continuous 36,000, the new model MWIs are slightly different from their existing model MWI counterparts. While all existing model MWIs except the Continuous 36,000 are specified to have a secondary chamber with a minimum gas residence time of 1/4 second (1/4-second combustion), all new model MWIs have one-second combustion (the existing Continuous 36,000, like the new Continuous 36,000, has one-second combustion).

Modified and reconstructed units are not reflected in Table 4-3. However, reconstruction, which is defined to involve an investment exceeding 50 percent of replacement cost, is not

TABLE 4-3. DISTRIBUTION OF NEW MWI SALES, Fifth Year

Industry	Model MWI[a]	Adjusted capacity per MWI (tons/yr)[b]	Projected nationwide population
Hospitals	Inter. 21,000	1,176	18
	Cont. 24,000	977	56
	Inter. 8,400	470	86
	Path. 2,000	172	3
	Inter. 2,000	115	237
	Batch 250	27	165
			565
Nursing homes	Inter. 8,400	470	1
	Inter. 2,000	115	17
			18
Veterinary facilities	Path. 2,000	172	1
	Inter. 2,000	115	5
			6
Research labs	Inter. 21,000	1,176	2
	Cont. 24,000	977	4
	Inter. 8,400	470	8
	Path. 2,000	172	1
	Inter. 2,000	115	21
			36
Commercial incineration facilities	Cont. 36,000	3,907	77
TOTAL			702

[a]Inter. = Intermittent, Cont. = Continuous, Path. = Pathological.
[b]Intermittent and continuous MWIs: lb/hr design capacity x 67% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Pathological MWI: lb/hr design capacity x 100% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Batch MWI: lb/batch design capacity x 67% x batches/yr x 1/2,000 tons/lb.

considered to be practical in light of improvements in MWI technology in recent years.

Because the projections in Table 4-3 are based on past MWI sales, they do not reflect potential new medical waste regulations (such as the NSPS and Emission Guidelines). On the other hand, sales in the period 1985-1989 may have already been influenced by the trends toward stricter regulation of MWIs at the state and local levels, stricter requirements for medical waste management (hauling, packaging, treatment, transportation, disposal, etc.), and more inclusive definitions of medical waste.

As indicated in Table 4-3, over three-quarters (565) of new MWI sales are projected to be to hospitals. Commercial incineration facilities follow with 77 units. Relatively few new units are projected to be sold to nursing homes, veterinary facilities, and research labs.

Although commercial incineration facilities account for only 11.0 percent (77 ÷ 702) of all new MWI sales, they account for 64.7 percent of the adjusted capacity of new unit sales. This is because MWIs at commercial incineration facilities are much larger on average than MWIs at other facilities. Hospitals account for 31.9 percent of the adjusted capacity of new unit sales. All other facilities account for only 3.4 percent.

The predominance of new capacity at commercial incineration facilities reflects the trends toward stricter regulation of medical waste incineration at the state and local levels and more inclusive definitions of medical waste. Stricter MWI regulations are increasing the per-ton cost advantage that offsite (commercial) MWIs tend to have over onsite MWIs as a result of the economies they achieve from being, as mentioned, larger on average. Meanwhile, expanding definitions of medical waste are increasing the ranks of facilities without onsite medical waste management expertise that are searching for offsite treatment and disposal solutions. As a result of these trends, the demand for offsite incineration is expected to increase. This will result in an increase in the number of commercial and regional incineration facilities, with ownership either by a commercial operator or a group of generators.

A new MWI sale can be a consequence of 1) replacing an existing MWI, 2) switching from an alternative medical waste treatment method (e.g., offsite contract disposal) to onsite incineration, or 3) industry growth. For the industries to which MWIs will be sold in the next five years, the precise contribution of each of these factors is not known. In most of these industries, all three factors may be at work. It is not believed, however, that switching from an alternative treatment method to onsite incineration will be prevalent. More restrictive requirements for medical waste incineration at the state and local levels are increasing the cost of onsite incineration not only in comparison to the cost of commercial incineration, but also in comparison to the cost of other alternative treatment methods. Most new MWI sales are expected to be replacement units. In contrast, new unit sales to commercial medical waste incineration facilities will mainly reflect growth in the industry resulting from increased demand for offsite contract treatment and disposal.

4.3.3 Relative Populations

For the major industries in which MWIs are operated, Table 4-4 compares the number of existing MWIs to the number of facilities, and the number of new MWI sales to the number of existing MWIs. A little less than half of all hospitals currently operate an MWI. In all other industries in which medical waste is generated (i.e., excluding commercial incineration facilities, which do not generate medical waste), a much lower percentage of facilities operate an MWI.

Survey responses from 15 commercial incineration facilities indicated that on average they operate about two MWIs. Consequently, as shown in Table 4-4, 75 commercial incineration facilities are assumed to operate the estimated 150 existing MWIs in the industry. MWI operators in all other industries typically operate only one MWI.

The total number of new MWI sales, 702, represents 14.1 percent of the total number of existing MWIs, 4,986. This does not reflect 14.1 percent growth in the number of MWIs because many new MWI sales will be replacement units. In relation to the number of existing MWIs, commercial incineration facilities will purchase the most new MWIs over the next five years (77/150 = 51.3%).

4.4 MWI OPERATORS VERSUS OFFSITE GENERATORS

The NSPS and Emission Guidelines will directly impact facilities that operate a new or existing MWI. The regulations will also indirectly impact facilities that generate medical waste and send it offsite to be incinerated. This is because such facilities will likely pay higher fees for commercial incineration as a result of the regulations. In the "Analysis of Economic Impacts for New Sources" and "Analysis of Economic Impacts for Existing Sources," facilities that generate medical waste but do not incinerate it onsite are termed "offsite generators."

The economic impact analysis is conducted by comparing control costs to financial and economic parameters of model facilities in the regulated industries. In Table 4-5, model facilities that are MWI operators are distinguished from model facilities that

TABLE 4-4. THE INCIDENCES OF EXISTING AND NEW MWIS, BY INDUSTRY

		Existing MWIs		New MWI sales, fifth year	
	Number of facilities	Number	Percent of all facilities	Number	Percent of all existing MWIs
Hospitals	6,882	3,150	45.8%	565	17.9%
Nursing homes	17,525	500	2.9%	18	3.6%
Veterinary facilities	21,496	550	2.6%	6	1.1%
Research labs	3,826[a]	500	<13.1%	36	7.2%
Commercial incineration facilities	75	150	100.0%[b]	77	51.3%
Other/ unidentified		136		-	-
TOTAL		4,986		702	14.0%

[a]Commercial facilities only. Does not include captive research labs.
[b]Based on two MWIs per facility. MWI operators in all other industries are assumed to operate only one MWI.

are offsite generators. A model facility is classified as an MWI operator if it represents an industry category or subcategory in which MWIs are commonly operated. For example, nursing homes with 100+ employees commonly operate an MWI. A model facility is classified as an offsite generator, on the other hand, if it represents an industry category or subcategory in which MWIs are not commonly operated. For example, nursing homes with fewer than 100 employees do not commonly operate an MWI.

In the economic impact analysis, the impacts of MWI controls are assessed for MWI operators, and the impacts of higher commercial (offsite) incineration fees are assessed for offsite generators.

Designation as an MWI operator or offsite generator depended mainly on total waste generated per facility and the number of MWIs in the industry in relation to the number of facilities represented by each model facility in the industry. For example, of the 17,525 nursing homes in the U.S. (see Table 4-1), 5,059 have 100+ employees. This was considered a sufficiently large number of facilities to fully account for the 500 existing MWIs in the industry (see Table 4-2). Moreover, estimated total waste generated by nursing homes with 0-19 employees and 20-99 employees was not deemed sufficient, on average, to warrant operating an MWI onsite. Therefore, nursing homes with 100+ employees were designated as MWI operators while nursing homes with 10-19 and 20-99 employees were designated as offsite generators.

Note in Table 4-5 that in addition to nursing homes, veterinary facilities and commercial research labs are split: the larger facilities are designated as MWI operators and the smaller facilities are designated as offsite generators.

4.5 OTHER CHARACTERISTICS OF THE REGULATED INDUSTRIES

For the industries included in the economic impact analysis, two scale parameters — revenue and employment — are shown in Table 4-6. Hospitals average the most revenue per facility, $32.5 million, as well as the most employment, 575 (full-time-equivalent). At the other end of the spectrum, dentists' offices and clinics average only $300,000 in revenue and 4.7 in employment.

The regulated industries cover the gamut of organizational structures: for-profit, not-for-profit, and public (government). Some not-for-profit and public establishments do not generate revenues; rather, they have a budget to pay for their expenses (fire departments, for example). Not-for-profit organizations often are underwritten by grants, donations, fund-raising proceeds, etc., while public establishments are typically

TABLE 4-5. MODEL FACILITY CLASSIFICATION: MWI OPERATORS VS. OFFSITE GENERATORS

MWI operators[a]	Offsite generators[b]
Hospitals 300+ beds 100-299 beds 50-99 beds 0-49 beds	Nursing homes 20-99 employees 0-19 employees
Nursing homes 100+ employees	Veterinary facilities 0-9 employees
Veterinary facilities 20+ employees 10-19 employees	Commercial research labs 0-19 employees
Commercial research labs 100+ employees 20-99 employees	Medical labs
Commercial incineration facilities	Dental labs
	Physicians' offices
	Dentists' offices and clinics
	Outpatient care Physicians' clinics Freestanding kidney dialysis facilities
	Freestanding blood banks
	Funeral homes
	Fire and rescue operations
	Correctional facilities

[a]Industry categories and subcategories in which MWIs are commonly operated. Therefore, the economic impacts of controls for an onsite MWI are assessed.

[b]Industry categories and subcategories in which MWIs are not commonly operated. Therefore, the economic impacts of higher fees for commercial (offsite) incineration are assessed.

TABLE 4-6. SCALE PARAMETERS: REVENUE AND EMPLOYMENT

		Revenue ($\$10^6$,1989)		Employment	
	Number of facilities	Industry-wide	Average per facility	Industry-wide	Average per facility
Hospitals	6,882	223,665	32.5	3,957,150[a]	575.0[a]
Nursing homes	17,525	32,137	1.8	1,332,608	76.0
Veterinary facilities	21,496	7,422	0.3	103,887	4.8
Laboratories					
Commercial research	3,826	11,847	3.1	137,517	35.9
Medical/dental	14,841	7,640	0.5	132,031	8.9
Funeral homes	22,000	9,900	0.5	154,000	7.0
Physicians' offices	191,278	95,295	0.5	1,032,901	5.4
Dentists' offices & clinics	104,213	27,406	0.3	492,742	4.7
Outpatient care					
Physicians' clinics	6,519	13,841	2.1	185,217	28.4
Freestanding kidney dialysis facilities	839	1,167	1.4	16,794	20.0
Freestanding blood banks	218	1,239	5.7	13,298	61.0
Fire & rescue operations	29,840	12,348	0.4	295,416	9.9
Correctional facilities	4,288	24,245	5.7	424,397	99.0
Commercial incineration facilities	75	150	2.0	N/A	N/A

[a]Full-time-equivalent.
N/A Not available.

appropriated tax revenues. In these cases, revenue in Table 4-6 is instead the budget.

Two industries in Table 4-6 — fire and rescue operations and correctional facilities — consist entirely of public establishments. The number of fire and rescue operations, 29,840, represents the number of public fire departments in the U.S. Public fire departments — which can be all-volunteer; fully career; or part career, part volunteer — are operated in the U.S. by county, municipal, township, and special-district governments. Correctional facilities are operated by Federal, state, county, and municipal governments.

To reflect the diversity of the regulated industries, various model facilities were created for the economic impact analysis. Hospitals, for example, are distinguished by

(1) <u>ownership</u>: Federal government vs. state government vs. local government vs. not-for-profit vs. for-profit;
(2) <u>location</u>: urban vs. rural;
(3) <u>function</u>: psychiatric vs. tuberculosis and other respiratory diseases vs. long-term other special and general vs. short-term other special and general; and
(4) <u>size</u>: 0-49 beds vs. 50-99 beds vs. 100-299 beds vs. 300+ beds.

Tax-paying establishments are distinguished from tax-exempt establishments for nursing homes, commercial research labs, dentists' offices and clinics, physicians' clinics, and freestanding kidney dialysis facilities. As evident in Table 4-5, employment-size distinctions are made for nursing homes, veterinary facilities, and commercial research labs.

Research laboratories can be either commercial or captive to a larger organization such as a pharmaceutical company or a research university. MWIs are operated by both types of research labs. However, economic impacts are assessed only for commercial research labs, which are independent and stand-alone. Captive research labs that are integrated with other operations of a larger organization will tend to be impacted less by the NSPS and Emission Guidelines than independent, stand-alone labs because there is more revenue to which a price increase recovering control costs can be applied. On the other hand, impacts measured for commercial research labs should be representative of impacts on captive research labs that are separate profit centers (and therefore are effectively stand-alone).

5.0 Costs of Medical Waste Incineration

5.1 INTRODUCTION

Baseline costs and control costs for each model combustor are presented in this chapter. For detailed derivations, please see the model plant description and cost report.

Several issues pertaining to the costs should be noted. First, based on differences in operation, emissions, and economic impacts, it was decided that pathological MWIs should be considered in a separate rulemaking. The cost estimates presented in this chapter were completed under the assumption that pathological MWIs would also be regulated under the proposed rules. Therefore, costs presented in this chapter will be slightly higher than actual costs expected to be incurred by the industries examined. Other discrepancies in cost estimates may be attributable to rounding. These discrepancies in costs are not regarded as significant because the economic impact analysis indicates that the impacts of the proposed rules are not significant. Using the lower but slightly more accurate costs would not affect this conclusion.

Second, control option 4 is not shown in this report because it is identical to control Option 5 except that control option 5 includes more monitoring requirements.

5.2 PER-MWI COSTS

Per-MWI capital costs and total annualized costs are presented in Tables 5-1 and 5-2, respectively. Total annualized cost is equal to annual operating and maintenance (O&M) costs plus the annualized capital cost. Capital costs are annualized using the Capital Recovery Factor. A discount rate of 10 percent and a useful life of 20 years are assumed.

Note in Tables 5-1 and 5-2 that baseline costs are identical under the NSPS and Emission Guidelines for the 36,000 lb/day continuous model (Continuous 36,000) but not for the other model MWIs. This is because with the exception of the Continuous 36,000, which is specified to have a secondary chamber with a minimum gas residence time of one second (one-second combustion), all existing model MWIs are specified to have 1/4-second combustion. In contrast, all new models are specified to have one-second combustion. This considers that older MWIs tend to have smaller secondary chambers than newer units, and that with the exception of large continuous units, the majority of existing MWIs were installed before 1985.

TABLE 5-1. PER-MWI CAPITAL COSTS (1989 DOLLARS)

Model MWI[a]		Baseline cost	Control cost (incremental to the baseline)			
			C.O.1[b]	C.O.2	C.O.3	C.O.5
NSPS						
Cont.	36,000	649,779	-	70,207	355,153	972,374
Inter.	21,000	237,659	-	70,207	355,153	972,374
Cont.	24,000	520,871	-	53,008	285,274	852,681
Inter.	8,400	156,822	-	39,244	229,352	756,649
Path.	2,000	96,345	-	26,534	177,714	667,534
Inter.	2,000	95,266	-	25,480	173,430	660,098
Batch	250	71,669	-	23,544	165,567	646,418
Emission Guidelines						
Cont.	36,000	649,779	-	176,206	461,152	1,078,373
Inter.	21,000	189,446	107,806	176,206	461,152	1,078,373
Cont.	24,000	485,558	85,047	130,644	362,910	930,317
Inter.	8,400	131,833	66,835	94,183	284,291	811,588
Path.	2,000	80,887	50,017	60,516	211,696	701,516
Inter.	2,000	80,599	48,622	57,722	205,672	692,340
Batch	250	58,454	46,061	52,596	194,619	675,470

[a]Cont. = Continuous, Inter. = Intermittent, Path. = Pathological.
[b]No control costs under the NSPS because new MWIs and existing continuous 36,000s are controlled at this level in the baseline.

TABLE 5-2. PER-MWI TOTAL ANNUALIZED COSTS (1989 DOLLARS)[a]

Model MWI[b]		Baseline cost	Control cost (incremental to the baseline)			
			C.O.1[c]	C.O.2	C.O.3	C.O.5
NSPS						
Cont.	36,000	294,000	-	47,356	207,714	453,781
Inter.	21,000	119,000	-	36,695	146,992	400,429
Cont.	24,000	169,000	-	30,043	114,809	338,001
Inter.	8,400	83,000	-	17,921	81,968	315,518
Path.	2,000	57,300	-	8,200	46,669	268,598
Inter.	2,000	52,600	-	9,301	50,581	273,354
Batch	250	33,600	-	9,567	46,471	267,718
Emission Guidelines						
Cont.	36,000	294,000	-	77,658	238,016	484,083
Inter.	21,000	108,407	36,155	59,643	169,940	424,513
Cont.	24,000	161,074	30,827	46,524	131,290	354,482
Inter.	8,400	77,806	19,665	29,162	93,209	327,214
Path.	2,000	53,888	11,481	14,935	53,404	275,333
Inter.	2,000	49,410	12,684	15,688	56,968	279,893
Batch	250	30,700	13,375	15,268	52,172	273,948

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.
[b]Cont. = Continuous, Inter. = Intermittent, Path. = Pathological.
[c]No control costs under the NSPS because new MWIs and existing continuous 36,000 are controlled at this level in the baseline.

Control costs in Tables 5-1 and 5-2 are incremental to the baseline. For example, the total capital cost for a new Continuous 36,000 under Control Option 2 (two-second combustion) is the baseline cost, $649,779, plus the control cost, $70,207, or $719,986. There are no control costs for new MWIs under Control Option 1 (one-second combustion) because they are controlled at this level in the baseline (recall that new model MWIs are all specified to have one-second combustion).

5.3 PER-FACILITY COSTS

In order to estimate economic impacts on facilities that operate an MWI, it is necessary to link the per-MWI control costs in Tables 5-1 and 5-2 to the model facilities that were judged to represent MWI operators (see Table 4-5 in Chapter 4). The assignment scheme for accomplishing this is demonstrated in Table 5-3.

The assignment scheme reflects that, in general, larger MWIs are expected to be located at larger facilities. In addition, total waste generated by the model facility in relation to MWI capacity is considered. For example, hospitals with 300+ beds generate sufficient waste, on average, to warrant operating a Continuous 24,000 or Intermittent 21,000 onsite. Hospitals with 300+ beds could also operate the much smaller Batch 250. However, the Batch 250 is not assigned to such hospitals because its economic impacts will be conservatively represented by the Continuous 24,000 and Intermittent 21,000, which are more costly to control. On the other hand, hospitals with 0-49, 50-99, and 100-299 beds do not generate sufficient waste, on average, to warrant operating a Continuous 24,000 or Intermittent 21,000. Instead, hospitals with 0-49 beds are assigned the smallest model MWI, the Batch 250; hospitals with 50-99 beds are assigned the two next-largest MWIs, the Intermittent 2,000 and Pathological 2,000; and hospitals with 100-299 beds are assigned the next-largest MWI, the Intermittent 8,400.

Survey responses from 15 commercial incineration facilities indicated that on average they operate about two MWIs. Therefore, commercial incineration facilities are stipulated to each operate two of the Continuous 36,000s assigned to them in Table 5-3. In all other industries, typically only one MWI is operated per facility (though there are exceptions). Consequently, the assigned MWIs are operated on a one-to-one basis. For those model facilities assigned more than one MWI in Table 5-3 (e.g., hospitals with 50-99 beds, which are assigned the Intermittent 2,000 and Pathological 2,000), separate economic impacts are measured for each MWI.

One implication of linking model MWIs to model facilities on a one-to-one basis is that the per-MWI costs in Tables 5-1 and 5-2

TABLE 5-3. THE ASSIGNMENT OF MODEL MWIs TO MODEL FACILITIES

Industry	Model facility size	Model MWI (by type and lb/day design capacity)						
		Continuous		Intermittent			Pathological	Batch
		36,000	24,000	21,000	8,400	2,000	2,000	250
Hospitals	0-49 beds							•
	50-99 beds					•	•	
	100-299 beds				•			
	300+ beds		•	•				
Nursing homes	100+ employees				•	•	•	
Veterinary facilities	10-19 employees					•	•	
	20+ employees					•	•	
Commercial research labs	20-99 employees					•	•	
	100+ employees		•	•	•			
Commercial incineration facilities	All sizes	•						

Note: Commercial incineration facilities operate, on average, about two MWIs, while facilities in other industries typically operate only one MWI. Therefore, all model facilities in this table operate the assigned model MWIs on a one-to-one basis, with the exception of commercial incineration facilities, which operate two 36,000 lb/day continuous MWIs.

can be construed as per-facility. For commercial incineration facilities, on the other hand, the per-facility costs are twice the costs of the Continuous 36,000 in Tables 5-1 and 5-2.

5.4 NATIONWIDE COSTS

Nationwide total annualized costs are presented in Table 5-4 for the NSPS and in Table 5-5 for the Emission Guidelines. Two distributions are provided: by model MWI and by industry. The costs by model MWI are derived by multiplying per-MWI total annualized costs in Table 5-2 by the number of MWIs nationwide, provided in the first column of Tables 5-4 and 5-5. The costs by industry are derived by summing for each model MWI the product of the total number of MWIs in the industry (see Chapter 4, Tables 4-2 and 4-3) and per-MWI total annualized costs in Table 5-2.

The control costs in Tables 5-4 and 5-5 are calculated assuming that all MWIs are controlled at the same level. For example, the nationwide total annualized control cost under Control Option 2 of the NSPS, $12,109,000, assumes that all new MWIs are subject to Control Option 2.

The nationwide total annualized baseline cost is approximately $63.6 million for new MWIs and approximately $335.0 million for existing MWIs. The nationwide total annualized control cost ranges up to $215.3 million under the NSPS and $1,415.6 million under the Emission Guidelines if all MWIs are subject to Control Option 5 (DI/FF with carbon) and continuous emissions monitoring.

5.5 PER-TON COSTS

Per-ton total annualized costs are presented in Table 5-6. The costs for the model MWIs are calculated by dividing per-MWI total annualized costs in Table 5-2 by adjusted capacity per MWI, listed in the first column of Table 5-6. The calculations therefore assume full utilization of adjusted capacity. If less than full adjusted capacity is used, the per-ton cost would be higher. The costs for the MWI subcategories (e.g., "total continuous") are calculated by dividing nationwide total annualized costs in Tables 5-4 and 5-5 by nationwide adjusted capacity, which is equal to the sum, for each model MWI in the subcategory, of the product of the number of MWIs nationwide (Tables 5-4 and 5-5) and adjusted capacity per MWI.

In Table 5-2 it was seen that larger MWIs tend to have higher total annualized baseline costs, as well as higher total annualized control costs. Table 5-6 demonstrates, in contrast, that on a per-ton basis, the baseline cost and control costs decrease as the size of the MWI increases (i.e., as adjusted capacity increases). This reflects economies of scale.

TABLE 5-4. NATIONWIDE TOTAL ANNUALIZED COSTS OF MEDICAL WASTE INCINERATION ($$10^3$, 1989)[a]: NSPS

	Number of MWIs nationwide	Baseline cost	Control cost (incremental to the baseline)			
			C.O.1[b]	C.O.2	C.O.3	C.O.5
By model MWI[c]:						
Cont. 36,000	77	22,638	-	3,646	15,994	34,941
Cont. 24,000	60	10,140	-	1,803	6,888	20,282
Total cont.	137	32,778	-	5,449	22,882	55,222
Inter. 21,000	20	2,380	-	734	2,940	8,009
Inter. 8,400	95	7,885	-	1,702	7,787	29,973
Inter. 2,000	280	14,728	-	2,604	14,163	76,539
Total inter.	395	24,993	-	5,040	24,890	114,521
Path. 2,000	5	287	-	41	233	1,343
Batch 250	165	5,544	-	1,579	7,668	44,173
TOTAL	702	63,602	-	12,109	55,673	215,259
By industry:						
Hospitals	565	36,926	-	7,692	35,920	163,034
Nursing homes	18	977	-	176	942	4,963
Veterinary facilities	6	321	-	55	299	1,635
Research labs	36	2,740	-	540	2,518	10,686
Commercial incineration facilities	77	22,638	-	3,646	15,994	34,941
TOTAL	702	63,602	-	12,109	55,673	215,259

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.
[b]No control costs because new MWIs are controlled at this level in the baseline.
[c]Cont. = Continuous, Inter. = Intermittent, Path. = Pathological.

TABLE 5-5. NATIONWIDE TOTAL ANNUALIZED COSTS OF MEDICAL WASTE INCINERATION ($$10^3$, 1989)[a]: EMISSION GUIDELINES

	Number of MWIs nationwide	Baseline cost	Control cost (incremental to the baseline)			
			C.O.1	C.O.2	C.O.3	C.O.5
By model MWI[b]:						
Cont. 36,000	154	45,276	-	11,959	36,654	74,549
Cont. 24,000	182	29,315	5,611	8,467	23,895	64,516
Total cont.	336	74,591	7,777	20,426	60,549	139,065
Inter. 21,000	170	18,429	6,146	10,139	28,890	72,167
Inter. 8,400	742	57,732	14,591	21,638	69,161	242,793
Inter. 2,000	2,097	103,613	26,598	32,898	119,462	586,936
Total inter.	3,009	179,774	47,335	64,675	217,513	901,896
Path. 2,000	1,306	70,378	14,994	19,505	69,746	359,585
Batch 250	335	10,285	4,481	5,115	17,478	91,773
TOTAL	4,986	335,028	74,587	109,721	365,286	1,492,318
By industry:						
Hospitals	3,150	195,509	50,223	68,503	226,766	939,566
Nursing homes	500	25,836	6,316	8,001	28,702	140,244
Veterinary facilities	550	29,383	6,383	8,257	29,576	151,693
Research labs	500	31,088	7,514	10,318	34,578	147,496
Commercial incineration facilities	150	44,100	2,110	11,649	35,702	72,612
Other/unidentified	136	9,112	2,041	2,993	9,962	40,707
TOTAL	4,986	335,028	72,421	109,721	365,286	1,492,318

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.
[b]Cont. = Continuous, Inter. = Intermittent, Path. = Pathological.

TABLE 5-6. PER-TON TOTAL ANNUALIZED COSTS OF MEDICAL WASTE INCINERATION (1989 DOLLARS)[a]

Model MWI[b]	Adjusted capacity per MWI (tons/yr)[c]	Baseline cost	Control cost (incremental to the baseline) C.O.1[d]	C.O.2	C.O.3	C.O.5
		NSPS				
Cont. 36,000	3,907	75	-	12	53	116
Cont. 24,000	977	173	-	31	118	346
Total cont.		91	-	15	64	154
Inter. 21,000	1,176	101	-	31	125	341
Inter. 8,400	470	177	-	38	174	909
Inter. 2,000	115	457	-	81	440	2,377
Total inter.		249	-	50	248	1,141
Path. 2,000	172	333	-	48	271	1,562
Batch 250	27	1,244	-	354	1,721	9,915
		Emission Guidelines				
Cont. 36,000	3,907	75	4	20	61	124
Cont. 24,000	977	165	32	48	134	363
Total cont.		96	10	26	78	174
Inter. 21,000	1,176	92	31	51	145	361
Inter. 8,400	470	166	42	62	198	696
Inter. 2,000	115	430	110	136	495	2,434
Total inter.		227	60	82	275	1,111
Path. 2,000	172	313	67	87	310	1,600
Batch 250	27	1,137	495	566	1,932	10,146

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.
[b]Cont. = Continuous, Inter. = Intermittent, Path. = Pathological.
[c]Continuous and intermittent MWIs: lb/hr design capacity x 67% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Pathological MWI: lb/hr design capacity x 100% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Batch MWI: lb/batch design capacity x 67% x batches/yr x 1/2,000 tons/lb.
[d]No control costs under the NSPS because new MWIs are controlled at this level in the baseline.

5.6 Costs of the Regulations

Costs for the proposed regulations are summarized in Tables 5-7 and 5-8. Table 5-7 shows per-MWI control costs. The NSPS and EG control costs reflect dry injection/fabric filter with carbon requirements for all new and existing MWIs. The costs can be confirmed by cross-referencing Tables 5-1 and 5-2. For example, the MACT capital costs for the Continuous 36,000 in Table 5-7 is $795,286. Referring to Table 5-1, it is seen that this is the cost under Control Option 5.

The per-MWI total annualized control costs in Table 5-7 are multiplied by the number of MWIs nationwide (Tables 5-4 and 5-5) to yield nationwide total annualized costs for the NSPS and EG requirements in Table 5-8. Under the NSPS, the nationwide total annualized control cost is approximately $213.9 million. Under the EG, the nationwide total annualized control cost is approximately $1.133 billion.

5.7 COMMERCIAL INCINERATION COSTS

The NSPS and Emission Guidelines will increase costs not only for establishments that operate an MWI, but also for establishments that generate medical waste and send it offsite to be incinerated. Such establishments can be expected to pay more for commercial (offsite) incineration as a result of the NSPS and Emission Guidelines. The impacts of the NSPS and Emission Guidelines on the cost of commercial incineration are estimated in Tables 5-9 and 5-10.

Nationwide total annualized commercial incineration control costs (i.e., total annualized control costs attributable to MWI capacity used for commercial incineration) are estimated in Table 5-9. This is accomplished by recognizing that, by definition, 100 percent of the adjusted MWI capacity of commercial incineration facilities is used for commercial incineration, and by assuming that 10 percent of adjusted MWI capacity at hospitals, nursing homes, veterinary facilities, and research labs is used for commercial incineration. (Ten percent may be high. This would have the advantage, however, of yielding conservative economic impacts for offsite generators.) These factors are multiplied by industry-wide MWI capacity to yield industry-wide commercial incineration capacity, and by industry-wide total annualized control costs in Tables 5-4 and 5-5 to yield industry-wide total annualized commercial incineration control costs (i.e., industry-wide total annualized control costs that are attributable to MWI capacity used for commercial incineration.)

As indicated in Table 5-9, it is estimated that 702,865 tons per year of existing MWI capacity is used for commercial

TABLE 5-7. PER-MWI CONTROL COSTS (INCREMENTAL TO THE BASELINE) FOR CONTROL OPTION 5 (1989 DOLLARS)

	Capital Cost	Total Annualized Cost
Model MWI[b]	Control Option 5[c]	Control Option 5[c]
Cont. 36,000	972,374	453,781
Inter. 21,000	972,374	247,958
Cont. 24,000	852,681	338,001
Inter. 8,400	756,649	315,518
Path. 2,000		
Inter. 2,000	660,098	273,354
Batch 250	646,418	267,718
Cont. 36,000	1,078,373	484,083
Inter. 21,000	1,078,373	424,513
Cont. 24,000	930,317	354,482
Inter. 8,400	811,588	327,214
Path. 2,000		
Inter. 2,000	692,340	279,893
Batch 250	675,470	273,948

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.
[b]Cont. = Continuous, Inter. = Intermittent, Path. = Pathological.
[c]Under the NSPS and EG, Control Option 5 reflects DI/FF w/carbon for all new and existing MWIs.

TABLE 5-8. NATIONWIDE TOTAL ANNUALIZED CONTROL COSTS (INCREMENTAL TO THE BASELINE) FOR THE REGULATORY ALTERNATIVES ($\$10^3$, 1989)[a]

	NSPS	EG
	Control Option 5	Control Option 5
By model MWI[b]:		
Cont. 36,000	34,941	74,549
Cont. 24,000	20,280	64,516
Total cont.	55,221	139,065
Inter. 21,000	8,009	72,592
Inter. 8,400	29,974	242,793
Inter. 2,000	76,539	586,936
Total inter.	114,522	902,321
Path. 2,000		
Batch 250	44,174	91,773
TOTAL[c]	213,917	1,133,159

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.
[b]Cont. = Continuous, Inter. = Intermittent, Path. = Pathological.
[c]Under the NSPS and EG, Control Option 5 reflects DI/DD w/carbon for all new and existing MWIs.

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Industry	MWI Capacity (tons/yr)	Assumed Percentage Used For Commercial Incineration	Commercial Incineration Capacity (tons/yr)	Nationwide Total Annualized Commercial Incineration Control Cost ($10^3,1989)[a]			
				C.O.1[b]	C.O.2	C.O.3	C.O.5
NSPS							
Hospitals	148,526	10%	14,853	--	769	3,592	16,303
Nursing Homes	2,425	10%	242	--	18	94	496
Veterinary Facilities	747	10%	75	--	6	30	164
Research Labs	12,607	10%	1,261	--	54	252	1,067
Commercial Incineration Facilities	300,839	100%	300,839	--	3,646	15,994	34,941
TOTAL	465,144		317,270		4,493 ($14/ton)	19,962 ($63/ton)	52,971 ($167/ ton)
Emission Guidelines							
Hospitals	868,642	10%	86,864	5,022	6,850	22,677	93,957
Nursing Homes	71,769	10%	7,177	632	800	2,870	14,024
Veterinary Facilities	91,351	10%	9,135	638	826	2,958	15,169
Research Labs	136,389	10%	13,639	752	1,032	3,458	14,750
Commercial Incineration Facilities	586,050	100%	586,050	2,110	11,649	35,702	72,612
TOTAL	1,754,201		702,865	9,154 ($13/ ton)	21,157 ($30/ton)	67,665 ($96/ton)	210,512 ($300/ ton)

[a]Annual O&M costs plus the annualized capital costs. Capital costs are annualized at 10% over a useful life of 20 years.

[b]No control costs under the NSPS because new MWIs are controlled at this level in the baseline.

TABLE 5-10. AVERAGE PER-TON TOTAL ANNUALIZED CONTROL COSTS FOR COMMERCIAL INCINERATION OF MEDICAL WASTE (1989 DOLLARS)[a]

		NSPS				
		Baseline	**C.O.1**	**C.O.2**	**C.O.3**	**C.O.5**
Emission Guidelines	**Baseline**	0	0	4	20	52
	C.O.1		9	13	29	61
	C.O.2			25	40	73
	C.O.3				86	118
	C.O.5					259

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.

Note: Calculated from Table 5-9 as 31.1 percent of the average per-ton control cost for the commercial incineration capacity of new MWIs, plus 68.9 percent of the average per-ton control cost for the commercial incineration capacity of existing MWIs.

incineration, and that over the next five years, new MWIs will account for 317,270 tons per year of commercial incineration capacity. For the NSPS, the nationwide total annualized commercial incineration control cost ranges up to $53.0 million ($167/ton) if all new MWIs are subject to Control Option 5. For the Emission Guidelines, the range is up to $210.5 million ($300/ton) if all existing MWIs are subject to Control Option 5.

Note that under every control option, the average per-ton costs of commercial incineration in Table 5-9 are lower than the per-ton costs of all model MWIs in Table 5-6 except the Continuous 36,000. This reflects that, on average, commercial MWIs are larger and more efficient than onsite MWIs.

Next, in Table 5-10, it is recognized that the cost of commercial incineration will be impacted by both the NSPS and Emission Guidelines. The increase in the average per-ton total annualized cost of commercial incineration is calculated as a weighted average, by commercial incineration capacity, of the per-ton control costs for new and existing MWIs in Table 5-9. Since total commercial incineration capacity is 317,270 tons per year for new MWIs and 702,865 tons per year for existing MWIs, the weights assigned to new MWIs and existing MWIs are 31.1 percent and 68.9 percent, respectively.

Consider Control Option 5 under the NSPS (i.e., <u>all</u> new MWIs are subject to Control Option DI/FF with carbon). In the case of the baseline for existing MWIs, the weighted-average increase in the total annualized cost of commercial incineration is (68.9% x 0) + (31.1% x $167/ton) = $52/ton. If, at the other extreme, all existing MWIs are subject to Control Option 5, the weighted-average increase in the total annualized cost of commercial incineration is (68.9% x $300/ton) + (31.1% x $167/ton) = $259/ton.

Table 5-10 presumes that the stringency of the NSPS is greater than or equal to that of the Emission Guidelines. For this reason, some combinations of a control option under the NSPS and a control option under the Emission Guidelines are not addressed in the table. If the NSPS and Emission Guidelines are of equal stringency, the incremental total annualized cost of commercial incineration is, as shown in Table 5-10, $9/ton under Control Option 1, $25/ton under Control Option 2, $86/ton under Control Option 3, and $259/ton under Control Option 5.

6.0 Medical Waste Treatment and Disposal

6.1 INTRODUCTION

Incineration, either onsite or offsite, is the predominant treatment method for medical waste. However, there are both onsite and offsite alternatives. According to a 1989 report by the National Solid Waste Management Association, while 60 percent of infectious waste at hospitals is incinerated onsite, 20 percent is steam-sterilized (autoclaved) onsite and 20 percent is treated offsite.[1]

In Section 6.2 of this chapter, recent trends in the U.S. medical waste treatment and disposal market are discussed. In Section 6.3, alternatives to onsite incineration — the most common of which are offsite incineration and onsite autoclaving — are identified. Estimated per-ton total annualized costs of onsite incineration, offsite incineration, and onsite autoclaving — before and after the NSPS and Emission Guidelines — are compared in Section 6.4. These costs are then used in Section 6.5 to calculate the costs of substituting from onsite incineration to offsite incineration and onsite autoclaving.

6.2 RECENT TRENDS

Medical waste has been the object in recent years of a great deal of regulatory activity, prompted in large part by growing public concern over proper treatment and disposal, which was galvanized by the wash-up of medical waste on East Coast beaches in the summer of 1988. As a result of the regulatory activity, there have been some pronounced trends in the medical waste treatment and disposal market. The most significant of these trends include:

- The quantity of medical waste generated has increased.
- Restrictions on general medical waste management (handling, transportation, treatment, disposal, etc.) at the state and local levels have increased.
- Restrictions on MWIs at the state and local levels have increased.
- More regional MWIs — either privately owned and/or operated, or cooperatively owned and/or operated by a group of generators — have been put into operation.
- Medical waste regulations have become more uneven from region to region and there is more uncertainty in the regulatory climate.
- The demand for alternative (to incineration) medical waste treatment methods has increased, and new

technologies have been developed and put into operation.

The first five of these trends are discussed in this section. The sixth trend is discussed in Section 6.3.

The quantity of medical waste generated has increased in recent years because the use of disposable items has increased and because new regulations have tended to define medical waste more inclusively. In addition, some waste haulers and landfill operators are refusing to accept waste from medical waste generators even if it is not infectious under applicable regulations or guidelines. This may require the waste to be treated and handled as infectious.

As a result of the increase in medical waste generated, the overall demand for medical waste treatment — both onsite and offsite — has increased.

Growth in the quantity of medical waste generated has perhaps been mitigated somewhat by more careful waste segregation practices, which have been encouraged by increases in treatment and disposal costs resulting from the new restrictions on MWIs and medical waste management in general.

Restrictions on general medical waste management have increased in recent years as many states and localities have instituted new regulations and extended guidelines to regulation status. As a result, the cost of medical waste treatment — both onsite and offsite — has increased. Those regulations that have targeted the transportation and disposal of medical waste (e.g., tracking requirements) have increased the relative attractiveness of onsite treatment methods, particularly onsite incineration, which reduces transportation and disposal requirements by significantly reducing volume and weight. On the other hand, regulations aimed at MWIs have favored nonincineration treatment methods, as well as offsite incineration because offsite/ commercial MWIs are larger and therefore more efficient (i.e., have lower per-ton costs), on average, than onsite MWIs.

The choice of a medical waste treatment method depends ultimately on the particular circumstances of the generator and the host community.[2] Such factors as 1) the nature and quantity of the waste generated, 2) the cost, 3) liability risk, 4) regulatory requirements, 5) the availability of permitted landfill space (after treatment, solid medical waste, including incinerated medical waste, is generally disposed of in a landfill), and 6) local air quality conditions, must be considered. While onsite treatment affords the generator more control over the ultimate disposal of medical waste (thereby reducing liability exposure) and can lower transportation and disposal costs, offsite treatment may be preferred if the generator has limited space for treatment equipment or, more importantly, does not want to devote resources to an operation that is outside its line of business.

No doubt in part due to the unevenness of regulations, there has been no clear trend towards onsite or offsite medical waste treatment. With respect to incineration, for example, the U.S. Congress, Office of Technology Assessment (OTA) concludes that "it is not clear whether there is a trend for more off-site or continued on-site incineration."[3]

As with medical waste management in general, MWIs have been subject to increasing restrictions in recent years. Most significantly, many states and localities have tightened emissions standards for MWIs and/or made it more difficult to get a permit for, and site, an MWI.

Emissions regulations have caused the cost of operating an MWI to increase. This has encouraged the use of nonincineration treatment technologies. It has also encouraged generators to use larger onsite MWIs and to send their medical waste offsite to be incinerated by commercial MWIs, which are larger on average than onsite MWIs. Due to economies of scale, large MWIs tend to have lower per-ton impacts from regulations than small MWIs.

Indeed, MWIs have been increasing in size. Further, new regional MWIs have been sited. Most regional MWIs are commercial (i.e., privately owned and/or operated), but some are cooperatively owned and/or operated by a group of generators. Commercial incineration has grown not only in response to regulations that have disproportionately impacted small onsite MWIs, but also in response to the expanding quantity of medical waste being generated.

The average cost of commercial incineration is estimated to be $600 per ton. This can vary substantially according to regional/local market conditions, however. For example, it can depend on the hauling distance from the generator to the MWI. Although large generators may be able to achieve a volume discount, commercial incineration may be most appropriate for small generators who do not have the expertise or resources to treat medical waste onsite.

MWI capacity in some areas of the country — such as the Northeast, Illinois, and Texas — is tight.[4] This is particularly likely to be the case if state emissions requirements have led to the closure of existing MWIs or if siting/permitting difficulties have limited the construction of new MWI capacity. Permitting an MWI can take over two years.[5] On the other hand, the Southeast, lower Midwest (centered in and around Oklahoma), and Ohio River Valley, for example, appear to have excess MWI capacity.[6] OTA concludes that temporary shortfalls of MWI capacity can be averted if the "adoption of new regulations is coordinated with careful planning and expedient permitting."[7]

Despite these restrictions, MWIs still have some advantages over other treatment methods. Incineration significantly reduces the volume and weight of medical waste (by up to 95%). This can reduce transportation and landfill-disposal costs. Also, incineration ensures the total destruction and sterilization of medical waste. Because the medical waste can therefore be identified as treated and disinfected, it may be more acceptable to some waste haulers and landfill operators. OTA concludes that incineration is "likely to remain, at least for the next decade, the cornerstone of (medical waste) management methods."[8] OTA notes, however, that incineration will continue to be effectively supplemented by alternative medical waste treatment methods.

As a result of all the regulatory activity at the state and local levels, the regulatory climate has become more variable and uncertain. While some states and localities have encouraged incineration (often indirectly by not approving alternative technologies), others have gone so far as to establish MWI moratoria. Moreover, some regulations have favored small MWIs, while others have favored larger units. Currently there are no Federal standards for MWIs. A "leveling of the playing field," which would be the effect of Federal regulations such as the NSPS and Emission Guidelines, would tend to benefit large MWIs because they have economies of scale.

6.3 ALTERNATIVES TO ONSITE INCINERATION

Landfilling of medical waste without prior treatment is becoming less and less common. Most states require prior treatment. Moreover, where landfills have discretion, they are becoming more likely to require prior treatment. Consequently, if not incinerated onsite, medical waste generally requires alternative treatment.

One alternative, as discussed in Section 6.2, is offsite incineration by a commercial or regional MWI. Another alternative is co-incineration with municipal solid waste. At least 31 municipal waste combustors (MWCs) are known to co-fire medical waste.[9] However, of these 31 units, only one accepts an average of 50 percent medical waste. The rest accept no more than 5 percent medical waste. Co-firing medical waste with municipal solid waste has had limited application due, for example, to 1) public concern over "importing" medical waste from other areas, 2) employee concern over exposure to medical waste in the workplace, and 3) mechanical considerations, such as potentially rupturing red bags in the handling system.[10]

There are also nonincineration alternatives to onsite incineration of medical waste. The commercial viability and use of nonincineration alternatives have increased in recent years for a number of reasons, including: 1) the quantity of medical waste generated has increased, 2) concern over MWI emissions has increased, with consequent regulatory action and increased costs for MWIs, 3) MWIs have become more difficult to permit and site, and 4) new technologies have been developed and brought to market.

By far the most common nonincineration medical waste treatment method is autoclaving (steam sterilization). Autoclaving is already a common onsite treatment method and is growing as an offsite treatment method. Although there are believed to be fewer than 24 commercial autoclaving facilities in the U.S., one waste management company reports that it is currently siting more autoclaves than incinerators.[11,12]

Autoclaving is usually combined with shredding or grinding, which can reduce the volume of the waste by up to 80 percent. The shredding or grinding can be done after autoclaving to render the waste unrecognizable, or before autoclaving to both render the waste unrecognizable and improve the efficiency of the disinfection process. If medical waste is shipped offsite to be autoclaved, onsite shredding or grinding may first be necessary if recognizability is a factor to the transporter.

By reducing volume, shredding or grinding can reduce disposal costs (for example, fewer trips to the landfill are required). Shredding or grinding does not reduce weight, however. In fact, autoclaving can increase the weight of medical waste because water is added in the process.

Autoclaving is not an appropriate treatment for some components of the medical waste stream, particularly pathological waste. About 10 percent of all medical waste cannot be autoclaved.[13] Supplementary treatment such as incineration may therefore be needed for a small portion of the medical waste stream. Another limitation of autoclaving is that some waste haulers and landfills are not willing to accept autoclaved waste because it cannot be identified as noninfectious without being tested. However, "informal discussions" with a number of hospital officials across the country indicated to OTA that "few refusals (of autoclaved medical waste) occur if a hospital works closely with landfill operators to explain their waste procedures."[14]

The remaining nonincineration medical waste treatment alternatives are all relatively new applications and have not yet gained widespread use in the U.S. These alternatives include chemical disinfection, microwave sterilization, thermal inactivation (dry heat sterilization), irradiation, and radiofrequency sterilization. Some of these methods may be more appropriate for either onsite or offsite treatment, but in general they can be used for both. Like autoclaving, these alternatives are generally combined with shredding or grinding to render the medical waste unrecognizable, to reduce the volume (by up to 80%), and, if performed prior to treatment, to make the disinfection process more efficient. Again, like autoclaving, weight is not reduced by these methods, and in fact may increase if water is added in the process.

Most of these alternatives are as effective as incineration and autoclaving in rendering medical waste noninfectious.[15] Thermal inactivation, however, is not considered as efficient as autoclaving.[16] With the possible exception of chemical disinfection, these alternatives, like autoclaving, cannot be used to treat pathological waste (the suitability of chemical disinfection for pathological waste is said by OTA to be "not clear").[17] Hence, as with autoclaving, supplementary treatment such as incineration may be needed for a small portion of the medical waste stream.

6.4 COMPARATIVE COSTS

Tables 6-1 and 6-2 compare the estimated per-ton total annualized costs of onsite incineration and its two most common alternatives, onsite autoclaving and offsite incineration. Table 6-1 shows costs before and after the NSPS, and Table 6-2 shows costs before and after the Emission Guidelines.

Baseline costs of onsite incineration in Tables 6-1 and 6-2, as represented by six of the seven model MWIs (the Continuous 36,000 is excluded because it is modeled as a commercial MWI, not an onsite MWI), are from Table 5-6 in Chapter 5. The costs of onsite incineration under the control options are derived from the incremental control costs in Table 5-6. As explained in Section 5.5, these per-ton costs assume full utilization of adjusted capacity. If less than full adjusted capacity is used, the per-ton cost would be higher.

The costs of onsite autoclaving in Tables 6-1 and 6-2 are for autoclave systems with the same capacities as the model MWIs. The cost of shredding is included. Again, full capacity utilization is assumed; less than full capacity utilization would result in a higher per-ton cost. Note that the cost of autoclaving is not affected by the NSPS or Emission Guidelines (i.e., under the control options, cost does not differ from the baseline). This assumption disregards the increase in cost that could come if the demand for autoclave systems were to increase as a result of the regulations.

TABLE 6-1. COMPARATIVE PER-TON TOTAL ANNUALIZED COSTS OF ONSITE MEDICAL WASTE INCINERATION AND ALTERNATIVE TREATMENT METHODS (1989 DOLLARS): NSPS[a]

Adjusted capacity/ treatment method[b,c]	Baseline	C.O.1	C.O.2	C.O.3	C.O.5
1,176 tons/yr					
Inter. 21,000	101	101	132	226	442
Onsite autoclaving	134	134	134	134	134
Offsite incineration[d]	600	600-609	604-625	620-686	652-859
977 tons/yr					
Cont. 24,000	173	173	204	291	519
Onsite autoclaving	160	160	160	160	160
Offsite incineration[d]	600	600-609	604-625	620-686	652-859
470 tons/yr					
Inter. 8,400	177	177	215	351	848
Onsite autoclaving	228	228	228	228	228
Offsite incineration[d]	600	600-609	604-625	620-686	652-859
172 tons/yr (path. waste)					
Path. 2,000	333	333	381	605	1,895
Onsite autoclaving	N.A.	N.A.	N.A.	N.A.	N.A.
Offsite incineration[d]	600	600-609	604-625	620-686	652-859
115 tons/yr					
Inter. 2,000	457	457	538	897	2,834
Onsite autoclaving	570	570	570	570	570
Offsite incineration[d]	600	600-609	604-625	620-686	652-859
27 tons/yr					
Batch 250	1,244	1,244	1,600	2,966	11,159
Onsite autoclaving	2,080	2,080	2,080	2,080	2,080
Offsite incineration[d]	600	600-609	604-625	620-686	652-859

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.

[b]Intermittent and continuous MWIs: capacity equals lb/hr design capacity x 67% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Pathological MWI: lb/hr design capacity x 100% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Batch MWI: lb/batch design capacity x 67% x batches/yr x 1/2,000 tons/lb.

[c]Inter. = Intermittent, Cont. = Continuous, Path. = Pathological.

[d]The low end of the range is based on no controls for existing MWIs under the Emission Guidelines, while the high end is based on the same control stringency for existing MWIs under the Emission Guidelines as for new MWIs under the NSPS.

N.A. Not applicable (because autoclaving cannot be used to treat pathological waste).

TABLE 6-2. COMPARATIVE PER-TON TOTAL ANNUALIZED COSTS OF ONSITE MEDICAL WASTE INCINERATION AND ALTERNATIVE TREATMENT METHODS (1989 DOLLARS): EMISSION GUIDELINES[a]

Adjusted capacity/ treatment method[b,c]	Baseline	C.O.1	C.O.2	C.O.3	C.O.5
1,176 tons/yr					
Inter. 21,000	92	123	143	237	453
Onsite autoclaving	134	134	134	134	134
Offsite incineration[d]	600-632	609-641	625-653	686-698	859
977 tons/yr					
Cont. 24,000	165	197	213	299	528
Onsite autoclaving	160	160	160	160	160
Offsite incineration[d]	600-632	609-641	625-653	686-698	859
470 tons/yr					
Inter. 8,400	166	208	228	364	862
Onsite autoclaving	228	228	228	228	228
Offsite incineration[d]	600-632	609-641	625-653	686-698	859
172 tons/yr (path. waste)					
Path. 2,000	313	380	400	624	1,914
Onsite autoclaving	N.A.	N.A.	N.A.	N.A.	N.A.
Offsite incineration[d]	600-632	609-641	625-653	686-698	859
115 tons/yr					
Inter. 2,000	430	540	566	925	2,864
Onsite autoclaving	570	570	570	570	570
Offsite incineration[d]	600-632	609-641	625-653	686-698	859
27 tons/yr					
Batch 250	1,137	1,632	1,702	3,069	11,283
Onsite autoclaving	2,080	2,080	2,080	2,080	2,080
Offsite incineration[d]	600-632	609-641	625-653	686-698	859

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.

[b]Intermittent and continuous MWIs: capacity equals lb/hr design capacity x 67% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Pathological MWI: lb/hr design capacity x 100% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Batch MWI: lb/batch design capacity x 67% x batches/yr x 1/2,000 tons/lb.

[c]Inter. = Intermittent, Cont. = Continuous, Path. = Pathological.

[d]The low end of the range is based on the same control stringency for new MWIs under the NSPS as for existing MWIs under the Emission Guidelines, while the high end is based on the maximum control stringency (C.O.5) for new MWIs under the NSPS.

N.A. Not applicable (because autoclaving cannot be used to treat pathological waste).

In contrast, the costs of offsite incineration, which follow from Table 5-10 in Chapter 5, increase as the control options become more stringent. For offsite incineration costs in Table 6-1, the low end of the range is based on no controls (i.e., the baseline) for existing MWIs under the Emission Guidelines, and the high end is based on the same control stringency for existing MWIs under the Emission Guidelines as for new MWIs under the NSPS. In Table 6-2, the low end is based on the same control stringency for new MWIs under the NSPS as for existing MWIs under the Emission Guidelines, and the high end is based on the maximum control stringency, Control Option 5, for new MWIs under the NSPS. This presumes that the stringency of the NSPS will be greater than or equal to that of the Emission Guidelines. While the cost of offsite incineration does vary by control option, it is shown in Tables 6-1 and 6-2 to not vary by capacity. This assumes, perhaps simplistically, that volume discounts are not achieved.

Tables 6-1 and 6-2 show that in the baseline, the cost of onsite incineration is generally lower than the cost of onsite autoclaving. The exception for both new MWIs (Table 6-1) and existing MWIs (Table 6-2) is the Continuous 24,000, which costs more than an autoclave system of the same capacity.

Offsite incineration, in the baseline, is more expensive on average than the Intermittent 2,000 and all larger models, but less expensive on average than the smaller Batch 250. Similarly, offsite incineration is less expensive in the baseline than an autoclave system of the same capacity as the Batch 250, but more expensive than larger autoclave systems.

With controls, the cost of onsite incineration relative to both onsite autoclaving and offsite incineration becomes less favorable. For onsite autoclaving, this is because it is unaffected by the NSPS and Emission Guidelines. For offsite incineration, this is because compared to onsite MWIs, commercial MWIs are larger on average and therefore have lower per-ton impacts from the NSPS and Emission Guidelines.

In Table 6-1, while all but one new MWI, the Continuous 24,000, are less expensive than onsite autoclaving under Control Options 1 and 2 (as in the baseline), no new MWIs (excluding the Pathological 2,000, for which autoclaving is not a suitable substitute) are less expensive under Control Options 3 and 5. In Table 6-2, all existing MWIs other than the Continuous 24,000 are less expensive than onsite autoclaving under Control Option 1 (as in the baseline), all but two existing MWIs (the Continuous 24,000 and Intermittent 21,000) are less expensive under Control Option 2, and no existing MWIs (again, excluding the Pathological 2,000) are less expensive under Control Options 3 and 5.

Meanwhile, while offsite incineration continues, as in the baseline, to be less expensive than both a new and existing Batch

250 under all control options, it also becomes less expensive than both the new and existing Pathological 2,000 under Control Option 5, and both the new and existing Intermittent 2,000 under Control Options 3 and 5. The larger model MWIs — the Intermittent 21,000, Continuous 24,000, and Intermittent 8,400 — remain less expensive than offsite incineration under all control options.

Estimated capital costs of newly built MWIs (i.e., new MWIs, but not ones that are modified or reconstructed) and new autoclave systems are compared in Table 6-3. Offsite incineration is not included because it has the advantage of requiring no capital investment. The capital costs of the newly built MWIs are in the baseline, i.e., before the NSPS. For capital control costs of the NSPS (and of the Emission Guidelines), see Table 6-1 in Chapter 5. Table 6-3 highlights that with the exception of the Pathological 2,000, for which autoclaving is not a suitable substitute, the capital cost of a newly built MWI exceeds the capital cost of a new autoclave system of the same capacity, across the board.

6.5 SUBSTITUTION COSTS

In addition to complying with the NSPS or Emission Guidelines by installing controls, MWI operators have the option of switching to an alternative medical waste treatment method. Comparative costs of onsite incineration, onsite autoclaving, and offsite incineration were presented in Section 6.4. Incremental per-ton total annualized costs of switching from onsite incineration in the baseline to onsite autoclaving and offsite incineration, based on the comparative per-ton total annualized costs in Tables 6-1 and 6-2, are presented in Table 6-4. The costs of switching to offsite incineration assume that new MWIs under the NSPS and existing MWIs under the Emission Guidelines are similarly controlled (the high end of the ranges in Table 6-1 and the low end of the ranges in Table 6-2).

For the two cases in Tables 6-1 and 6-2 in which onsite incineration is more expensive than an alternative in the baseline — the Continuous 24,000 versus onsite autoclaving, and the Batch 250 versus offsite incineration — Table 6-4 shows that the incremental cost of substitution is negative. In all other cases, the incremental cost of substitution is positive because onsite autoclaving and offsite incineration are more expensive than onsite incineration in the baseline. The incremental cost of switching to offsite incineration increases as the control options become more stringent, reflecting that the cost of commercial incineration is impacted by the NSPS and Emission Guidelines. In contrast, the incremental cost of switching to onsite autoclaving, which is assumed to be unaffected by the regulations, is independent of the control level.

TABLE 6-3. COMPARATIVE CAPITAL COSTS OF NEWLY BUILT MWIS AND NEW AUTOCLAVE SYSTEMS (1989 DOLLARS)

Adjusted capacity[a]	Newly built MWI			Cost of a new autoclave system[c]
	Unit[b]		Baseline cost	
1,176 tons/year	Inter.	21,000	237,659	173,376
977 tons/year	Cont.	24,000	520,871	136,509
470 tons/year	Inter.	8,400	156,822	107,015
172 tons/year	Path.	2,000	96,345	N.A.
115 tons/year	Inter.	2,000	95,266	77,521
27 tons/year	Batch	250	71,669	66,406

[a]Intermittent and continuous MWIs: lb/hr design capacity x 67% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Pathological MWI: lb/hr design capacity x 100% x charging hrs/day x operating days/yr x 1/2,000 tons/lb. Batch MWI: lb/batch design capacity x 67% x batches/yr x 1/2,000 tons/lb.

[b]Inter. = Intermittent, Cont. = Continuous, Path. = Pathological.

[c]Includes the cost of a shredder.

N.A. Not applicable (because autoclaving cannot be used to treat pathological waste, and therefore is not a suitable substitute for the Pathological 2,000).

TABLE 6-4. INCREMENTAL PER-TON TOTAL ANNUALIZED COSTS OF SUBSTITUTION (1989 DOLLARS)[a]

Model MWI[b]		Switching to:					
		Onsite autoclaving	Offsite (commercial) incineration[c]				
			Baseline	C.O.1	C.O.2	C.O.3	C.O.5
NSPS							
Inter.	21,000	33	499	508	524	585	758
Cont.	24,000	(13)	427	436	452	513	686
Inter.	8,400	51	423	432	448	509	682
Path.	2,000	N.A.	267	276	292	353	526
Inter.	2,000	113	143	152	168	229	402
Batch	250	836	(644)	(635)	(619)	(558)	(365)
Emission Guidelines							
Inter.	21,000	42	508	517	533	594	767
Cont.	24,000	(5)	435	444	460	521	694
Inter.	8,400	62	434	443	459	520	693
Path.	2,000	N.A.	287	296	312	373	546
Inter.	2,000	140	170	179	195	256	429
Batch	250	943	(537)	(528)	(512)	(451)	(278)

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.
[b]Inter. = Intermittent, Cont. = Continuous, Path. = Pathological.
[c]Assumes the same control stringency for new MWIs under the NSPS and existing MWIs under the Emission Guidelines (the high end of the ranges in Table 6-1 and the low end of the ranges in Table 6-2).
N.A. Not applicable (because autoclaving cannot be used to treat pathological waste).

The per-ton substitution costs in Table 6-4 can be compared to the per-ton control costs in Chapter 5, Table 5-6 to see which costs more: controls or substitution?

Multiplying the per-ton costs in Table 6-4 by tons treated per year, represented by the adjusted capacities of the model MWIs (see, for example, Tables 6-1 and 6-2), yields incremental per-MWI total annualized costs of substitution in Table 6-5. These are the incremental annual costs that facilities substituting for one of the model MWIs could be expected to incur. For both onsite incineration and onsite autoclaving, full utilization of adjusted capacity is assumed. As a result, the incremental total annualized costs of switching to both onsite autoclaving and offsite incineration are conservative, i.e., may be overstated. The incremental total annualized cost of onsite autoclaving is conservative because the number of tons treated per year may be overstated (no doubt, many MWIs and autoclave systems are not operated at full capacity). The incremental total annualized cost of offsite incineration is conservative not only because the number of tons treated per year may be overstated, but also because the per-ton cost of onsite incineration in the baseline would be understated if full capacity is not utilized. This would lead to an overstatement of the per-ton cost differential between offsite incineration and onsite incineration in the baseline.

TABLE 6-5. INCREMENTAL PER-MWI TOTAL ANNUALIZED COSTS OF SUBSTITUTION (1989 DOLLARS)[a]

Model MWI[b]		Switching to:					
		Onsite autoclaving	Offsite (commercial) incineration[c]				
			Baseline	C.O.1	C.O.2	C.O.3	C.O.5
NSPS							
Inter.	21,000	38,808	586,824	597,408	616,224	687,960	891,408
Cont.	24,000	(12,701)	417,179	425,972	441,604	501,201	670,222
Inter.	8,400	23,970	198,810	203,040	210,560	239,230	320,540
Path.	2,000	N.A.	45,924	47,472	50,224	60,716	90,472
Inter.	2,000	12,995	16,445	17,480	19,320	26,335	46,230
Batch	250	22,572	(17,388)	(17,145)	(16,713)	(15,066)	(9,855)
Emission Guidelines							
Inter.	21,000	49,392	597,408	607,992	626,808	698,544	901,992
Cont.	24,000	(4,885)	424,995	433,788	449,420	509,017	678,038
Inter.	8,400	29,140	203,980	208,210	215,730	244,400	325,710
Path.	2,000	N.A.	49,364	50,912	53,664	64,156	93,912
Inter.	2,000	16,100	19,550	20,585	22,425	29,440	49,335
Batch	250	25,461	(14,499)	(14,256)	(13,824)	(12,177)	(7,506)

[a]Annual O&M costs plus the annualized capital cost. Capital costs are annualized at 10 percent over a useful life of 20 years.
[b]Inter. = Intermittent, Cont. = Continuous, Path. = Pathological.
[c]Assumes the same control stringency for new MWIs under the NSPS and existing MWIs under the Emission Guidelines (the high end of the ranges in Table 6-1 and the low end of the ranges in Table 6-2).
N.A. Not applicable (because autoclaving cannot be used to treat pathological waste).

7.0 Economic Impacts

7.1 INTRODUCTION

The major aims of the economic impact analysis were to determine 1) the average industry-wide price increase necessary to recover control costs; 2) the market response to the industry-wide price increase — specifically, impacts on output, employment, revenue, and market structure; 3) the extent to which individual establishments can recover control costs by increasing prices; 4) the availability of capital to finance the investment in controls; 5) the extent of economic hardship if control costs cannot be fully recovered or if capital is not readily available; and 6) the extent to which the impacts of control costs can be, and will be, avoided by switching to an alternative medical waste treatment and disposal method.

[note: This analysis was completed before a decision was made to exclude pathological MWIs from the proposed rules. Annualized costs used as an input to estimate economic impacts were also calculated before this decision was made. Consequently, the economic impact estimates presented in this chapter are expected to be slightly greater than actual economic impacts expected to be incurred by the industries examined. This discrepancy is not expected to significantly affect the conclusion of the analysis - that the economic impacts of the proposed rules are not significant.]

In Section 7.2 of this chapter, the general methodology of the economic impact analysis is presented. In Section 7.3, the findings of the analysis are summarized. The major conclusions of the analysis are presented in Section 7.4. Impacts on small entities are discussed in Section 7.5.

For more-detailed discussion and analysis of economic impacts, please refer to the "Analysis of Economic Impacts for New Sources" and the "Analysis of Economic Impacts for Existing Sources."

7.2 METHODOLOGY

7.2.1 Model Facility Approach

The economic impact analysis was conducted by comparing control costs and incremental substitution costs to economic and financial parameters of the regulated industries. As discussed in Sections 4.4 and 4.5 of Chapter 4, model facilities were created for this purpose. The major parameters assigned to the model facilities include annual revenue, annual before-tax net income, employment, and total liabilities (assets minus net worth). (Revenue and employment were presented in Chapter 4, Table 4-6.) The parameters are averages per facility; hence, the model facilities represent average or typical establishments. The model facility data can be used directly to estimate per-facility economic impacts or can be aggregated to estimate industry-wide economic impacts.

7.2.2 Industry-wide and Per-facility Analyses

Indeed, two separate economic impact analyses were conducted: industry-wide and per-facility. The general methodologies of the industry-wide and per-facility analyses, and how they are linked, can be understood with the aid of the flow chart in Figure 7-1. The figure applies specifically to facilities with an onsite MWI (MWI operators).

7.2.2.1 Industry-wide Analysis.

The linchpin for the industry-wide analysis was calculating the "market price increase." This represents the average industry-wide price increase necessary to recover control costs. It is calculated as the ratio of the industry-wide total annualized control cost (see Chapter 5, Tables 5-4 and 5-5) to industry-wide revenue.

Because most, if not all, of the regulated industries are fragmented, actual price increases will vary from market segment to market segment according to such factors as 1) the number of facilities, 2) the number of facilities operating an MWI, 3) the distribution of MWI types, and 4) market structure and pricing mechanisms. Ideally, the average price increase in each market segment would be measured. However, it is not possible to define and characterize literally hundreds of regional and local market segments. Therefore, the market price increase, which is an average price increase across all market segments, was used to represent the average price increase in each individual market segment.

Based on the market price increase, the percent change in industry-wide output was then estimated. The change in output is inversely related to the market price increase depending on the price elasticity of demand, which measures the percent change in quantity demanded (which in market equilibrium is equal to output) along the demand curve in response to a percent change in price. The more inelastic demand is, the greater is the ability to increase price without an attendant decline in output. Relatively elastic demand, on the other hand, restricts the ability to increase price without losing output.

The majority of medical waste is generated by industries involved in the provision of health care. In general, the demand for health care is considered to be relatively inelastic. There are several reasons for this. First, other than abstinence, there is no substitute for health care. Secondly, good health is a virtual necessity. As a result of these factors, consumers are relatively captive to providers (e.g., physicians) and often are given little choice in medical decisions. Another factor is that health care providers tend to compete more on quality than price. Finally, and perhaps most importantly, patients are to a great extent insulated from changes in the price of health care because medical bills are commonly paid by third parties such as government programs (e.g., Medicare, Medicaid) and private insurers. In 1987, third parties paid for 72 percent of the cost of health care in the U.S.[1]

There are some offsetting factors. For one, co-payments and deductibles on insurance plans still constitute a significant share of consumers' budgets. Further, health care providers have been meeting increased resistance to price increases from third-party payers. Finally, abstaining from health care is apparently an option, as 37 million Americans are presently without health insurance.[2]

Demand elasticity was qualitatively assessed for each regulated industry. Most of the regulated industries were judged to face relatively inelastic demand. The assessments ranged from "slightly elastic" demand for research laboratories and medical laboratories, to "highly inelastic" demand for hospitals, physicians' offices, physicians' clinics, freestanding kidney dialysis facilities, freestanding blood banks, funeral homes, fire and rescue operations, and correctional facilities.

The next step in the industry-wide analysis was to estimate the change in industry-wide employment. This was done assuming a fixed labor-output ratio. As a result, the percent change in employment is equal to the percent change in output. The change in employment can then be calculated as the percent change in employment multiplied by baseline employment.

The final step in the industry-wide analysis was to estimate the change in industry-wide revenue. The percent change in revenue is equal to the sum of the market price increase and the percent change in output, plus their cross-product. The change in revenue, in turn, is equal to the percent change in revenue multiplied by baseline revenue. Revenue will increase in response to a price increase if demand is relatively inelastic and decrease if demand is relatively elastic (it does not change if the elasticity is "unitary").

7.2.2.2 <u>Per-facility Analysis</u>.

In the per-facility analysis, impacts were measured for both MWI operators and offsite generators (defined in Chapter 4, Section 4.4). The impacts of control costs were assessed for MWI operators and the impacts of higher commercial incineration fees were assessed for offsite generators.

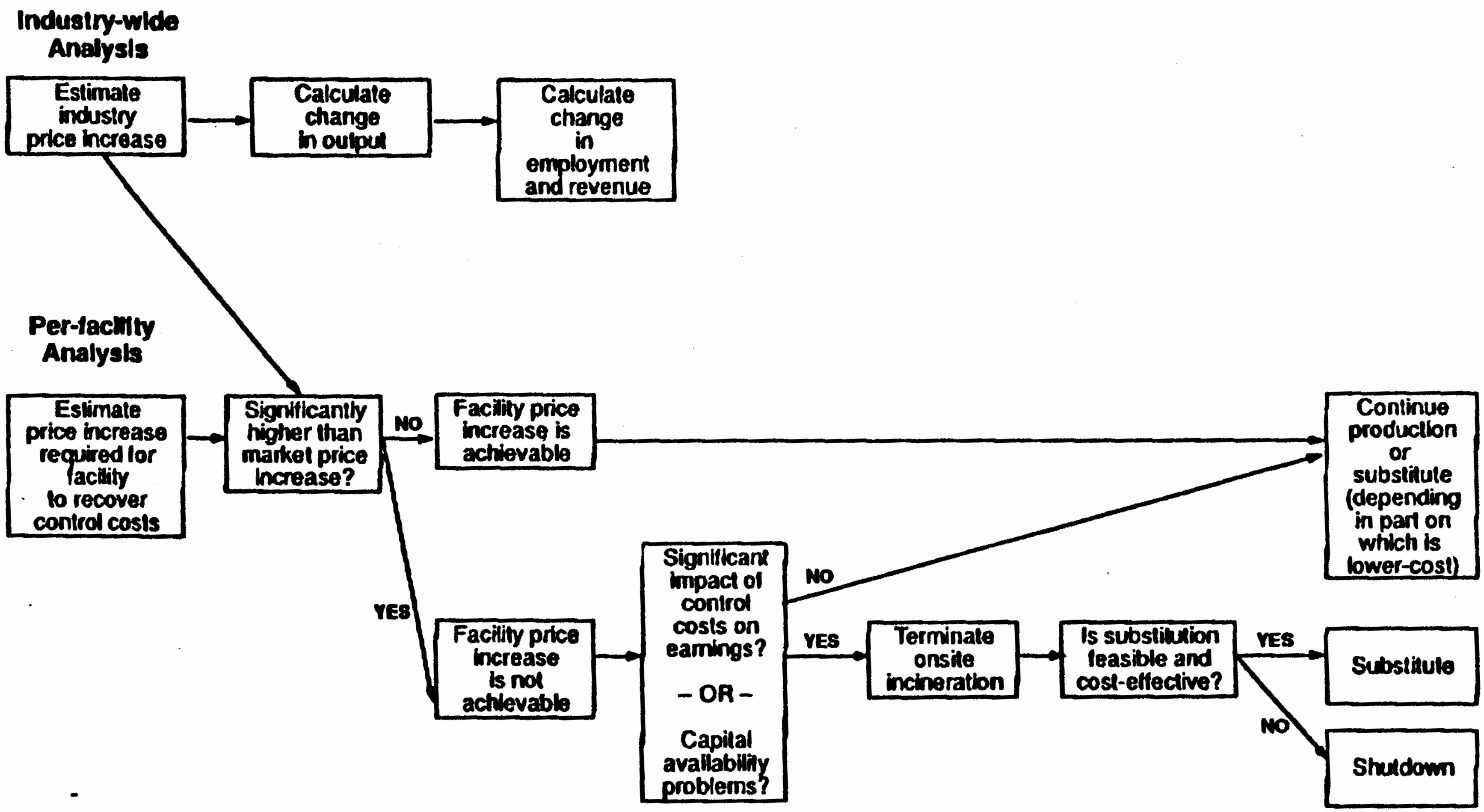
Capital and total annualized control costs for MWI operators were established in Chapter 5, Section 5.3. Unlike MWI operators, offsite generators have no capital control costs. Higher fees for commercial incineration imply incremental annual costs, however. Incremental annual costs of offsite (commercial) incineration were calculated for offsite generators by multiplying average per-ton total annualized control costs for commercial incineration (see Chapter 5, Table 5-10) by estimated total waste generated annually per facility. For the per-ton control costs, it was assumed that the NSPS and Emission Guidelines are of equal stringency. This results in costs of $9/ton under Control Option 1, $25/ton under Control Option 2, $86/ton under Control Option 3, and $259/ton under Control Option 5. Total waste generated annually per facility was estimated by disaggregating industry-wide total waste generated (see Chapter 4, Table 4-1) by employment. This uses employment as a scale factor, and assumes a constant ratio of waste generated to employment. Also, by using total waste generated annually in the calculation, it is assumed, conservatively, that 100 percent of waste generated is sent offsite to be incinerated.

The per-facility analysis was triggered by calculating the "facility price increase," which is the price increase necessary for an individual facility to recover control costs. For MWI operators, the facility price increase is calculated as the ratio of total annualized control cost to revenue. For offsite operators, it is calculated as the ratio of the incremental annual cost of offsite incineration to revenue.

As demonstrated in Figure 7-1, the facility price increase was then compared to the market price increase (in this way, the industry-wide and per-facility analyses are linked). If the facility price increase was less than one percentage point higher then the market price increase, it was judged to be achievable (market structure was also considered in this assessment). This is based on the premise that facilities are constrained to set prices that are not far out of line with the average industry-wide price.

As Figure 7-1 demonstrates for MWI operators, if the facility price increase is achievable, onsite incineration can be continued. This does not rule out substitution from occurring, however. Recall from Chapter 6, Tables 6-1 and 6-2 that relative to the costs of onsite autoclaving and offsite incineration, the cost of onsite incineration increases under the NSPS and Emission Guidelines, especially as the control options become more

Figure 7-1


Industry-wide Analysis
Estimate industry price increase
Calculate change in output
Calculate change in employment and revenue
Per-facility Analysis
Estimate price increase required for facility to recover control costs
Significantly higher than market price increase?
NO
Facility price increase is achievable
YES
Facility price increase is not achievable
Significant impact of control costs on earnings? – OR – Capital availability problems?
NO
YES
Terminate onsite incineration
Is substitution feasible and cost-effective?
YES
NO
Continue production or substitute (depending in part on which is lower-cost)
Substitute
Shutdown

stringent. As a result, onsite autoclaving and/or offsite incineration are less expensive than onsite incineration in some cases. It may therefore be cost-saving to substitute (though, as discussed in Chapter 6, cost is not the only consideration in choosing a medical waste treatment and disposal method).

For facilities that may not be able to achieve the facility price increase, two questions were then asked: 1) will absorbing the portion of control costs that cannot be recovered with a price increase result in an unsustainable decline in earnings?, and 2) will capital generally be available to finance the investment in controls?

The impact on earnings of absorbing control costs was gauged by the ratio of total annualized control cost (or the incremental annual cost of offsite incineration for offsite generators) to before-tax net income. This measures the percent decrease in before-tax net income if control costs are fully absorbed (i.e., if no price increase is achieved). In the short run, the theoretical closure point is when variable costs exceed revenues. Because some costs are fixed, net income would have to decline by more than 100 percent for this closure threshold to be reached. In the long run, on the other hand, firms are free to redeploy assets to investments that yield higher rates of return. Consequently, the closure point in the long run is when the rate of return on capital falls below the opportunity cost of capital (i.e., the rate of return on the best alternative use of capital). To account for the greater vulnerability to closure in the long run, a 10 percent decrease in before-tax net income resulting from full absorption of control costs was used as the criterion for a significant, or unsustainable, impact.

The availability of capital to MWI operators (offsite generators have no capital control costs) was gauged by 1) the ratio of the capital control cost to before-tax net income and 2) the ratio of the capital control cost to total liabilities. The first measurement gives an indication of the ability to finance the investment from internal cash flow (before-tax net income is used as a proxy for cash flow). A value exceeding 100 percent was taken to indicate that debt may have to be issued (normally for an investment in pollution controls, it is assumed that equity will not be issued because the investment does not add to productive capacity). The second measurement indicates the impact on capital structure in the event debt is issued. A value exceeding 20 percent was taken to indicate that debt capital may not be readily available. This considers that creditors are reluctant to lend to firms with a high degree of financial leverage (i.e., high ratio of debt to net worth) because there is a high risk that debt cannot be repaid. An exception was made, however, if the facility price increase is achievable. Because total annualized control cost includes the annualized cost of capital, comprising depreciation and interest, achieving the facility price increase implies that additional cash flow will be generated to service new debt. In theory, the capital markets should recognize this and make financing available, regardless of the impact of the new debt on total liabilities.

If, in the event that the facility price increase is not achievable, neither the impact on net income of full-cost absorption nor the availability of capital is prohibitive, MWI operators (Figure 7-1) can continue onsite incineration, though, again, substitution may take place, depending in part on which is lower-cost. If either is prohibitive, however, onsite incineration will have to be terminated. In this event, substitution will be necessary in order to avoid closure — or at least to avoid the termination of operations that result in, or are dependent on, the generation of medical waste.

In Chapter 6, it was seen that with some restrictions, applying mainly to pathological waste, substitution for onsite incineration of medical waste is feasible. The feasibility of substitution is further suggested by the fact, as indicated in Chapter 4, Table 4-4, that over half of all hospitals and an even greater majority of nursing homes, veterinary facilities, and research labs currently do not operate an MWI. Although the impacts of control costs can be avoided by substituting, there are also incremental costs associated with substituting. These costs were presented in Chapter 6, Tables 6-4 and 6-5.

To determine the impacts of substitution, per-facility incremental total annualized costs of substitution were assessed in the same way that per-facility total annualized control costs were. First, the price increases necessary to recover the incremental costs of switching to onsite autoclaving and offsite incineration were measured. These were calculated as the ratio of the incremental total annualized cost of substitution to revenue. A price increase exceeding one percent was considered potentially unachievable. Secondly, if the price increase was potentially unachievable, the impact on net income of full absorption of incremental substitution costs was measured. This was calculated as the ratio of the incremental total annualized cost of substitution to before-tax net income. A decrease in before-tax net income exceeding 10 percent was considered significant in the long run.

7.2.3 Analysis of Impacts on Taxpayers

There are three primary ways in which the NSPS and Emission Guidelines will impact taxpayers. First, taxpayers will indirectly subsidize tax-exempt debt issued by public and some not-for-profit institutions to finance the investments in pollution controls. This is because tax-exempt debt results in a tax-revenue shortfall for the government that must ultimately be made up for by other taxes. Measuring this impact was beyond the scope of the analysis. Secondly, taxpayers will underwrite the costs to government programs that pay for health care. In the long run, it can be expected that, on average, about 35 percent of the price increases achieved by health care providers will be passed on to taxpayers (in the form of higher taxes). This is because government programs pay for about 35 percent of health care in the U.S. (in 1987, Medicare 16.2%, Medicaid 9.9%, other government programs 8.9%).[3] Thirdly, taxpayers will pay for the costs to public establishments. Medical waste generators that are exclusively government-owned include fire departments and correctional facilities. Many hospitals are also public. In addition, it is possible that some tax-exempt nursing homes, commercial research laboratories, outpatient clinics, and dentists' clinics are government-owned.

The last of these three impacts was gauged by calculating the annual per-capita impact of full absorption of control costs for three of the above categories of public establishments: public hospitals, fire departments, and correctional facilities. Impacts were calculated by dividing per-facility total annualized control costs by the average populations of the types of government units in the U.S. that have jurisdiction over hospitals, fire departments, and correctional facilities. Six types of government units operate hospitals: Federal, state, county, municipal, township, and special-district. Fire departments are operated by county, municipal, township, and special-district governments. Correctional facilities are operated by Federal, state, county, and municipal governments. Total annualized control costs for hospitals followed from assigning the Intermittent 8,400 to Federal and local (including county, municipal, township, and special-district) hospitals because they average 100-299 beds (296 and 113, respectively), and from assigning the Intermittent 21,000 to state hospitals because they average 300+ beds (387). Fire departments and correctional facilities are offsite generators. Therefore, incremental annual costs of offsite incineration were used.

Total population was used as a substitute for the total number of taxpayers, which is not known for the different types of government units. Since not all residents are taxpayers, per-capita impacts underestimate impacts per taxpayer.

7.3 FINDINGS

7.3.1 Industry-wide Impacts

For all control options under both the NSPS and Emission Guidelines, the market price increase is less than one percent in all but two of the industries that generate medical waste. This is in large part due to the predominance in every industry of facilities that do not operate an MWI. The two exceptions are veterinary facilities and commercial research labs under Control Option 5.

Owing to a small market price increase and/or relatively inelastic demand, all impacts on industry-wide output, employment, and revenue in industries generating medical waste are likewise minor. Output impacts in all but two industries, for example, are less than one percent. Under the most stringent control scenario — Control Option 5 — output declines by less than 0.1 percent in the majority of industries, including hospitals.

Although it is sizable, the market price increase was not calculated for the commercial incineration industry. This is because it is expected to be achievable as a result of the increase in the demand for alternatives to onsite incineration, including offsite incineration, that will be brought about by the NSPS and Emission Guidelines. It is expected that the demand for offsite incineration will increase to offset the negative impact on output of control costs. Already, commercial incineration capacity is tight in the face of growing demand (see Chapter 6). The NSPS and Emission Guidelines will give impetus to this demand growth by increasing the relative cost of onsite incineration. Given these forces, a contraction in industry output, or in the rate of growth in industry output, is unlikely. One implication of no adverse impact on output is that prices can be raised to fully recover control costs. This is because profitability must be undiminished (implying full recovery of control costs) in order for regulated facilities to have the incentive to maintain their level of, or rate of growth in, output.

7.3.2 Per-facility Impacts[a]

7.3.2.1 MWI Operators.

MWI operators in the following cases may not be able to recover control costs with a price increase because the facility price increase exceeds the market price increase by more than one percentage point (the assigned model MWIs are in parentheses):

- Hospitals with fewer than 50 beds under Control Options 3 and 5 of both the NSPS and Emission Guidelines (Batch 250)

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[a]This analysis was completed before a decision was made to exclude pathological MWIs from the proposed rules. Therefore, any impacts noted for pathological MWIs are no longer relevant for the proposed rules.

- Hospitals with 50-99 beds under Control Option 5 of both the NSPS and Emission Guidelines (Pathological 2,000, Intermittent 2,000)
- A limited number of hospitals with 100+ beds (including tuberculosis hospitals, of which there are only four nationwide) under Control Option 5 of both the NSPS and Emission Guidelines (Intermittent 8,400)
- Nursing homes with 100+ employees under Control Options 3 and 5 of both the NSPS and Emission Guidelines (Intermittent 8,400; for the Emission Guidelines only, Pathological 2,000; Intermittent 2,000)
- Veterinary facilities with 10-19 employees under Control Options 2, 3, and 5 of the NSPS, and Control Options 1, 2, 3, and 5 of the Emission Guidelines (Pathological 2,000, Intermittent 2,000)
- Veterinary facilities with 20+ employees under Control Options 3 and 5 of both the NSPS and Emission Guidelines (Pathological 2,000, Intermittent 2,000)
- Tax-paying commercial research labs with 20-99 employees under Control Options 3 and 5 of both the NSPS and Emission Guidelines (Pathological 2,000, Intermittent 2,000)
- Tax-exempt commercial research labs (average number of employees equals 148) under Control Option 5 of the NSPS and Emission Guidelines (Intermittent 8,400)

Note that no cases involve the three largest model MWIs, the Continuous 36,000, Intermittent 21,000, and Continuous 24,000. With respect to the Continuous 36,000, this is because it is modeled as a commercial MWI and, as explained earlier, commercial incineration facilities are expected to be able to recover control costs. With respect to the Intermittent 21,000 and Continuous 24,000, this is because they offer economies of scale to facilities generating a sufficient amount of medical waste.

The following types of MWI operators, in turn, may have to terminate onsite incineration because control costs may be prohibitive, i.e., the impact on earnings of full-cost absorption may be unsustainable and/or capital to finance the investment in controls may not be readily available (assigned model MWIs in parentheses):

- Hospitals with fewer than 50 beds under Control Options 3 and 5 of both the NSPS and Emission Guidelines (Batch 250)
- Hospitals with 50-99 beds under Control Option 5 of both the NSPS and Emission Guidelines (Pathological 2,000, Intermittent 2,000)
- A limited number of hospitals with 100+ beds (including tuberculosis hospitals, of which there are only four nationwide) under Control Option 5 of both the NSPS and Emission Guidelines (Intermittent 8,400)

- Nursing homes with 100+ employees under Control Options 3 and 5 of both the NSPS and Emission Guidelines (Intermittent 8,400; for the Emission Guidelines only, Pathological 2,000; Intermittent 2,000)
- Veterinary facilities with 10-19 employees under Control Options 3 and 5 of both the NSPS and Emission Guidelines (Pathological 2,000, Intermittent 2,000)
- Veterinary facilities with 20+ employees under Control Option 5 of both the NSPS and Emission Guidelines (Pathological 2,000, Intermittent 2,000)
- Tax-paying commercial research labs with 20-99 employees under Control Options 3 and 5 of both the NSPS and Emission Guidelines (Pathological 2,000, Intermittent 2,000)
- Tax-exempt commercial research labs (average number of employees equals 148) under Control Option 5 of the NSPS and the Emission Guidelines (Intermittent 8,400)

If onsite incineration must be terminated, it will be necessary to substitute in order to avoid shutting down operations that result in, or are dependent on, the generation of medical waste. For most of the cases in which substitution may be necessary, there is at least one medical waste treatment alternative (onsite autoclaving or offsite incineration) with incremental costs that could be recovered with a price increase under one percent. This includes all cases of hospitals.

There are no capital costs associated with switching to offsite incineration. Onsite autoclaving, on the other hand, does have capital costs. Estimated capital costs of new autoclave systems and newly built MWIs were compared in Chapter 6, Table 6-3. The capital costs of new autoclave systems are lower across-the-board. Since it is implicit in the projection of new MWI sales that capital costs can be financed, it follows that the capital costs of new autoclave systems that are substituted for a newly built MWI can also be financed. Comparing Table 6-3 with Table 5-1 in Chapter 5, it is seen that the capital costs of new autoclave systems are comparable to capital control costs under Control Option 2 of the Emission Guidelines. Since it was concluded that capital costs under Control Option 2 of the Emission Guidelines can be financed, it follows that the capital costs of new autoclave systems that are substituted for an existing MWI can also be financed.

In the following three cases, however, the price increase necessary to recover incremental substitution costs may not be achievable because it exceeds one percent, and earnings would be significantly impacted (i.e., would decline by more than 10%) if incremental substitution costs were fully absorbed:

- Nursing homes with 100+ employees that operate the Pathological 2,000 under Control Options 3 and 5 of the Emission Guidelines only
- Veterinary facilities with 10-19 employees that operate the Pathological 2,000 under Control Options 3 and 5 of both the NSPS and Emission Guidelines
- Tax-paying commercial research labs with 20-99 employees that operate the Pathological 2,000 under Control Options 3, and 5 of both the NSPS and Emission Guidelines

Note that all three cases involve the Pathological 2,000. However, since the analysis has been completed, a decision has been made to exclude pathological MWIs from the proposed rules.

7.3.2.2 Offsite Generators.

For the model facilities classified as offsite generators in Chapter 4, Table 4-5, all facility price increases are less than 0.7 percent. They are therefore considered achievable. As a result, there are no adverse impacts on earnings. Capital availability is not an issue because offsite generators do not have capital control costs.

Since MWI operators and offsite generators coexist in all industries that generate medical waste, the model facilities classified as MWI operators in Chapter 4, Table 4-5 also represent some offsite generators. Economic impacts could not be calculated for these offsite generators because comparative scale parameters (e.g., revenue) for MWI operators and offsite generators are not known. For example, it is likely that among nursing homes with 100+ employees (classified as MWI operators), MWI operators are larger on average than offsite generators. How much larger is not known.

However, it can be said that, on average, offsite generators will be impacted less by the NSPS and Emission Guidelines than MWI operators of comparable size. This is because commercial MWIs are larger than average and therefore have comparatively low control costs per ton. Further, offsite generators are no doubt less dependent on offsite incineration, on average, than MWI operators are dependent on onsite incineration. An offsite generator with no dependence on offsite incineration, for example, will not be directly impacted by the NSPS and Emission Guidelines (there may be indirect impacts if the demand for, and as a result the price of, alternative medical waste treatment methods increases).

In some situations, an offsite generator could experience similar impacts to an MWI operator of comparable size. The offsite generator would have to be as dependent on offsite incineration as the MWI operator is dependent on onsite incineration (normally 100%), and would have to rely on incineration by a commercial MWI that is comparable in size and efficiency to the MWI used by the onsite operator. In addition, the commercial MWI operator would have to fully pass along the pro rata share of control costs to the offsite generator (because medical waste treatment and disposal capacity is at a premium, this is expected to occur).

7.3.3 Impacts on Taxpayers

Annual per-capita impacts of control costs for Federal and state hospitals are insignificant, ranging up to only eight cents for state hospitals under Control Option 5 of the NSPS, and nine cents for state hospitals under Control Option 5 of the Emission Guidelines. Per-capita impacts for local hospitals are higher, ranging up to $101.16 under Control Option 5 of the NSPS, and $104.91 under Control Option 5 of the Emission Guidelines. These impacts are accounted for by township hospitals. Among government units operating hospitals, townships have the lowest average population, 3,119. It is likely to be rare, however, for a facility operating an MWI to be under the jurisdiction of a government unit with a population of only several thousand. Therefore, per-capita impacts for hospitals — or any other type of facility, for that matter — operating an MWI are not considered to be significant, in general. In any case, if any impacts are significant, they can be avoided by substituting.

Per-capita impacts for fire departments and correctional facilities are negligible. At the most they are only eight cents.

7.4 CONCLUSIONS

Because industry-wide output impacts are small, the NSPS and Emission Guidelines are not expected to significantly affect market structure or competition in any regulated industry. No industry should require significant restructuring such as through closures or consolidations.

Substitution will be a major impact of the NSPS and Emission Guidelines not only because it will be <u>necessary</u> in some cases in order to avoid prohibitive impacts of the control costs, but also because it can be <u>cost-saving</u> (though, as discussed, cost is not the only consideration in choosing a medical waste treatment and disposal method). In Chapter 6, Tables 6-1 and 6-2, it was seen that relative to the costs of onsite autoclaving and offsite incineration, the cost of onsite incineration increases under the NSPS and Emission Guidelines. As the control options increase in stringency, there is a cost-saving alternative to more and more MWIs. The likelihood of substitution is greatly influenced by the control stringencies of the control options.

There are few cases of a cost-saving alternative under the Emission Guidelines. Because it is more stringent, the NSPS will result in a greater incidence of substitution than the Emission Guidelines. Furthermore, there is likely to be a greater incidence of substitution for small MWIs than for large MWIs. This is because small MWIs have comparatively high per-ton cost impacts from the NSPS and Emission Guidelines. As a result, under the more stringent control options, cost savings from substituting tend to be greater for small MWIs than for large MWIs (see Chapter 6, Tables 6-1 and 6-2). Again, this applies particularly to the NSPS because it is more stringent.

For new MWIs, substitution means that planned investments will be foregone in favor of other medical waste treatment and disposal methods. Onsite autoclaving and offsite (commercial) incineration, and perhaps other alternatives such as offsite (commercial) autoclaving, should benefit by experiencing accelerated demand growth. For most of the model MWIs, onsite autoclaving is a lower-cost alternative than offsite incineration. This suggests that onsite autoclaving may be the more common substitute. Offsite incineration is a lower-cost alternative to the Batch 250, however. This suggests that offsite incineration may be the more cost-effective alternative for small facilities generating insufficient medical waste to achieve low per-ton costs operating an autoclave system. Because it requires no capital investment, offsite incineration may also be more appropriate for facilities with limited capital (e.g., small facilities). Offsite incineration may also be necessary if landfills or waste haulers are unwilling to accept autoclaved waste. Finally, autoclaving cannot be used to treat some types of medical waste, particularly pathological waste (as a result, autoclaving is not a substitute for the Pathological 2,000). Therefore, offsite incineration may be needed for supplementary treatment.

To the extent that substitution takes place, sales of onsite MWIs will be adversely affected (sales of commercial MWIs are not expected to be similarly affected because the demand for offsite incineration will increase as a result of the NSPS and Emission Guidelines). From Table 4-3 in Chapter 4, it can be calculated that commercial incineration facilities account for 64.7 percent of the capacity of projected new unit sales over the next five years. Hospitals account for most of the remaining capacity — 31.9 percent. This implies — assuming a strong correlation between the capacity and sale price of MWIs — that, as a result of the NSPS, up to approximately one-third of the market for new MWIs in the next five years could face competition from alternative medical waste treatment methods. Actual erosion of the market will depend greatly on the extent of substitution by hospitals.

This leaves open the possibility that some MWI vendors will go out of business. Vendors with a high degree of concentration in onsite, noncommercial MWIs would be most vulnerable. On the other hand, vendors of autoclave systems and other alternative medical waste treatment systems should benefit from the NSPS and Emission Guidelines.

Because the NSPS is more stringent than the Emission Guidelines, some MWI operators may be prompted to postpone replacing existing MWIs with new MWIs. This could adversely affect sales of both commercial and noncommercial MWIs. Ultimately, existing MWIs have to be replaced, but replacement may not occur until after the market for new MWIs has been disrupted. It is not known whether some MWI vendors might, as a result, go out of business.

7.5 IMPACTS ON SMALL ENTITIES

In accordance with the Regulatory Flexibility Act of 1980, it is necessary to determine if the NSPS and Emission Guidelines will have a "significant economic impact on a substantial number of small entities." Small entities affected by the regulations include small businesses, small not-for-profit organizations, and small government jurisdictions.

The Small Business Administration (SBA) standard for a "small" business is 500 employees or fewer for SIC 8731, Commercial Physical and Biological Research (research labs), and annual sales of $3.5 million or less for all other industries affected by the NSPS and Emission Guidelines. The EPA "Guidelines for Implementing the Regulatory Flexibility Act" (February 9, 1982) suggest that not-for-profit organizations are "small" if they are not dominant in their field.[4] Government jurisdictions are "small" if they have a population of 50,000 or less.

According to the EPA "Guidelines," the criterion for a "substantial number" is 20 percent or more of all small entities impacted by a regulation.

The impacts of control costs may be significant for some small government jurisdictions. However, in general, significant impacts can be avoided by substituting. Moreover, the number of government jurisdictions that are significantly impacted should not be "substantial." Not only will small government units with jurisdiction over one or more MWI operators not typically be significantly impacted, but the majority of small government units probably have jurisdiction only over offsite generators, which in general are not significantly impacted.

Many small businesses and small not-for-profit organizations will be impacted by the NSPS and Emission Guidelines. In fact, according to the SBA criteria, all regulated industries except hospitals consist predominantly of small entities. Some of these facilities may be significantly impacted by the NSPS and Emission Guidelines. However, in general, significant impacts can be avoided by substituting. In any case, the number of facilities that are significantly impacted should not be "substantial." This is in part because the great majority of small entities generating medical waste do not operate an MWI.

Because they are not medical waste generators, commercial incineration facilities cannot substitute, per se. However, due to an increase in the demand for offsite incineration that will result from the NSPS and Emission Guidelines, they are expected to be able to fully recover control costs by increasing prices.

The NSPS and Emission Guidelines will also probably not have differential impacts favoring large facilities. On the one hand, due to economies of scale, relative impacts will be less for large facilities that operate an MWI than for small facilities that operate an MWI. On the other hand, offsite generators — especially to the extent that they do not send their medical waste offsite to be incinerated — will be impacted less, on average, than MWI operators. Since MWIs tend to be operated by large facilities, this results in differential impacts favoring small facilities. Net differential impacts will depend on the comparative strengths of these two countervailing tendencies. Since the majority of facilities in all industries in which medical waste is generated are offsite generators, net differential impacts will probably favor small facilities. Because they do not generate medical waste, commercial incineration facilities are an exception. However, although relative impacts will most likely be greater for small commercial incineration facilities than for large ones, facilities of all sizes are expected to be able to pass along control costs to customers.

8.0 BENEFITS ANALYSIS

The Agency has attempted to identify the potential environmental benefits expected to result from implementation of the proposed regulation. This chapter provides the following discussion: (1) a qualitative description of health and environmental benefit categories associated with implementation of the proposed regulation and (2) a quantitative assessment of the benefit categories previously described that can be readily monetized.

8.1 Qualitative Description of Benefits

This section qualitatively discusses the potential health and welfare benefits associated with air emission reductions resulting from implementation of the proposed regulations. The proposed regulations are expected to reduce emissions of a wide range of hazardous air pollutants as well as emissions of criteria pollutants. The discussion will focus on adverse health effects resulting from exposure to the above pollutants as well as welfare effects, such as effects on crops and other plant life, resulting from exposure to ozone.

8.1.1 Hazardous Air Pollutants

Exposure to HAPs can cause a variety of adverse health effects. Some hazardous air pollutants to be affected by the proposed rules are classified as probable human carcinogens and therefore, are suspected of containing cancer-causing agents. These hazardous air pollutants have not been proven as human carcinogens but are nevertheless, linked with causing adverse health effects such as lesions or abnormal cell growth (which may eventually lead to cancer). The benefits of reducing emissions of these non-carcinogenic HAPs is that adverse health effects resulting from exposure to these pollutants will be decreased. Several other pollutants are not classifiable as to their carcinogenicity but there are documented health effects associated with exposure to these pollutants. This section describes some of these health effects.

Health Benefits of Reducing Hazardous Air Pollutant Emissions

According to baseline emission estimates, this source category of medical waste incinerators currently emits approximately 41,000 Mg of cadmium, hydrochloric acid, lead, and mercury annually. The Emission Guidelines are expected to reduce these HAP emissions by approximately 40,100 Mg annually. The Background Information Document provides a detailed explanation of the methods used to calculate pollutant emissions and emission reductions.

The major pathways for human exposure to environmental contaminants are through inhalation, ingestion, or dermal contact. Airborne contaminants may be toxic to the sites of immediate exposure, such as skin, eyes, and linings of the respiratory tract. Toxicants may also cause a spectrum of systemic effects following absorption and distribution to various target sites such as liver, kidneys, and the central nervous system.

Exposure to contaminants in the air can be acute, chronic, or subchronic, Acute exposure refers to a very short-term (i.e., less than or equal to 24 hours), usually single-dose, exposure to a contaminant. Health effects often associated with acute exposure include: central nervous system effects such as headaches, drowsiness, anesthesia, tremors, and convulsions; skin, eye, and respiratory tract irritation; nausea; and olfactory effects such as awareness of unpleasant or disagreeable odors. Many of these effects are reversible and disappear with cessation of exposure. Acute exposure to very high concentrations or to low levels of highly toxic substances can, however, cause serious and irreversible tissue damage, and even death. A delayed toxic response may also occur following acute exposure.

Chronic exposures are those that occur for long periods of time (many months to several years). Subchronic exposure falls between acute and chronic exposure, and usually involves exposure for a period of weeks or months. Generally, the health effects of greatest concern following intermittent or continuous long-term exposures are those that cause either irreversible damage and serious impairment to the normal functioning of the individual, such as cancer and organ dysfunction, or death.

The risk associated with exposure to a toxic agent is a function of many factors, including the physical and chemical characteristics of the substance, the nature of the toxic response, and the dose required to produce the effect, the susceptibility of the exposed individual, and the exposure situation. In many situations, individuals may be concurrently or sequentially exposed to a mixture of compounds, which may influence the risk by changing the nature and magnitude of the toxic response.

Of the four HAPs identified, two pollutants - cadmium and lead, are classified as a probable human carcinogens. Current baseline emissions of cadmium are estimated to be 5.62 Mg/yr. Acute human inhalation exposure to high levels of cadmium in humans may cause adverse effects on the lung, such as bronchial and pulmonary irritation. A single exposure to high levels of cadmium can result in long-lasting impairment of lung function. Chronic human exposure to cadmium in air may affect the lung, with effects such as bronchitis and emphysema, the kidney, and the nasal passages. Chronic oral exposure to cadmium in animals and humans results in effects on the kidney, bone, immune system, blood, and nervous system. The Emission Guidelines are expected to reduce these cadmium emissions from existing sources by 5.40 Mg/yr. In addition, the NSPS is projected to reduce cadmium emissions from new sources by approximately 1.32 Mg/yr.

MWI operations are estimated to emit approximately 77.53 Mg of lead annually. Acute exposure to lead has been shown to cause adverse effects such as gastrointestinal symptoms, such as colic, brain and kidney damage, and even death. Chronic exposure to lead can affect the blood, such as anemia, and the nervous system, such as neurological symptoms and slowed nerve conduction in peripheral nerves. Occupational exposure to high levels of lead has been associated with a severe depression of sperm count and decreased function of the prostate and/or seminal vesicles in male workers and a high likelihood of spontaneous abortion in pregnant women. Prenatal exposure to lead produces toxic effects on the human fetus, including increased risk of preterm delivery, low birth weight, and reduced mental activity. The Emission Guidelines are expected to reduce lead emissions from existing MWIs by 75.98 Mg annually. In addition, the NSPS is projected to reduce lead emissions from new sources by 18.82 Mg annually.

The remaining two HAPs are not classifiable as to their human carcinogenicity due to lack of sufficient scientific data. However, adverse effects resulting from exposure to these pollutants may give rise to toxic endpoints other than cancer and gene mutations. Results from human and/or animal studies provide information on the types of adverse health effects associated with exposure to these pollutants.

Baseline hydrochloric acid emissions from existing MWIs are estimated to be approximately 41,197 Mg annually. In humans, acute inhalation exposure to HcL may cause coughing, hoarseness, inflammation and ulceration of the respiratory tract, chest pain, and pulmonary edema. Acute oral exposure may cause corrosion of the mucous membranes, esophagus, and stomach, with nausea, vomiting, and diarrhea reported. HCl is corrosive to the eyes, skin, and mucous membranes. Chronic occupational exposure to hydrochloric acid has been reported to cause gastritis, chronic bronchitis, dermatitis, and photosensitization in workers. Prolonged exposure to low concentrations may also cause dental discoloration and erosion. The Emission Guidelines are expected to reduce HCl emissions from existing sources by approximately 39,961 Mg/yr. The NSPS are projected to reduce an additional 9,746 Mg of HCl annually.

Current annual emissions of mercury are estimated to be approximately 58.57 Mg. Acute inhalation exposure to high levels of elemental mercury in humans results in central nervous system effects, such as hallucinations, delirium, and suicidal tendencies. Gastrointestinal effects and respiratory effects, such as chest pains, dyspnea, cough, pulmonary function impairment, and interstitial pneumonitis have also been noted from inhalation exposure to elemental mercury. Symptoms noted after acute oral exposure to inorganic mercury compounds include a metallic taste in the mouth, nausea, vomiting, and severe abdominal pain. The acute lethal dose for most inorganic mercury compounds, for an adult, is 1 to 4 grams. The central nervous system is the major target organ for elemental mercury toxicity in humans. Effects noted include erethism (increased excitability), irritability, excessive shyness, insomnia, severe salivation, gingivitis, and tremors. Chronic exposure to elemental mercury also affects the kidney. The EG are expected to reduce Hg emissions by approximately 52.57 Mg annually. The NSPS are projected to reduce Hg emissions by approximately 13.05 Mg annually.

Reduction in emissions of the above pollutants is expected to reduce cancer risk as well as the occurrence of adverse health effects such as those described above. However, due to data deficiencies, further quantification of the benefits associated with these emission reductions is not possible. Table 8-1 presents a summary of the HAP emission reductions.

Since lack of data prevents the above benefit categories from being monetized, it is expected that this omission will lead to an underestimation of the health benefits associated with the proposed regulations. The Agency cannot confidently characterize the magnitude of the underestimation.

8.1.2 Dioxins

The proposed rules are expected to reduce emissions of 2,3,7,8-chlorinated dibenzodioxins (CDD) and 2,3,7,8-chlorinated dibenzofurans (CDF), isomers of dioxins. Baseline emission estimates of CDD/CDF are estimated to be approximately 285 Kg annually. Although 2,3,7,8-tetrachlordibenzo-p-dioxin (TCDD) is listed as a HAP, its isomers are not. However, the health effects described below are believed to result from exposure to any of the three compounds - TCDD, CDD, or CDF. Table 8-2 provides a summary of the dioxin emission reductions. The following discussion provides a brief description of the adverse health effects associated with exposure to dioxins.

In humans, the most prevalent effect from exposure to CDD/CDF is chloracne, a dermatological condition that is a direct result of

Table 8-1
HAP Emission Reductions

Pollutant	EG (Mg/yr)	NSPS (Mg/yr)
Cd	5.4	1.32
HCl	1,235.92	9,746.23
Hg	52.71	13.05
Pb	75.98	18.83

Table 8.2
Dioxin Emission Reductions

Pollutant	EG (Kg/yr)	NSPS (Kg/yr)
CDD/CDF	284.73	21.68

exposure. The condition can be short-lived but has also been known to persist in some patients for as long as 40 years.

There is evidence in some animal studies that dioxins cause adverse reproductive and developmental effects. The fact that a wide variety of developmental events, across several different species can be affected, lends more support to the possibility that similar effects could occur (possibly with different severity levels) in humans.

Another health effect linked to dioxin exposure is a change in hormone levels. Exposure to dioxins can cause some hormone levels to decrease. The significance of these effects has not been determined but this research has formed the basis for the emerging concern for "environmental hormones." An association between reproductive system and dioxin exposure has been seen in monkeys but there are no studies showing a link in humans.

The EG is expected to reduce CDD/CDF emissions from existing sources by approximately 285 Kg/yr. The NSPS is expected to reduce CDD/CDF emissions from new sources by approximately 21 Kg/yr.

Reductions in emissions of CDD/CDF is expected to reduce the possibility of adverse health effects such as those described above from occurring. However, lack of data prevents further quantification of the benefits associated with these emission reductions. Once again, the total monetized benefits estimates are expected to be underestimated due to the omission of this benefit category from total estimates.

8.1.3 Criteria Pollutants

Particulate matter (PM) and carbon monoxide (CO) are classified as criteria pollutants by the EPA. Baseline emissions caused by medical waste incineration are estimated to be approximately 11,300 Mg/yr. Baseline emissions of CO are estimated to be approximately 13,100 Mg/yr.

The presence of PM emissions has been linked with not only causing adverse health effects, such as exacerbating asthmatic conditions, but also adverse welfare effects, such as materials damage and household soiling. The EG is expected to reduce baseline PM emissions to be approximately 10,800 Mg annually. In addition, the NSPS is expected to reduce PM emissions from new sources by approximately 1,600 Mg annually.

In the health category, health effects associated with PM exposure include mortality as well as various types of acute and chronic morbidity. Potential morbidity effects include increases in respiratory distress, aggravation of existing respiratory and cardiovascular disease, impairment of the body's defense mechanisms, damage to lung tissues, and carcinogenesis.

In addition, welfare effects such as soiling, visibility effects, and acidic deposition effects on materials and aquatic/terrestrial life are possible. For example, increases in PM emissions may result in increased soiling of households, requiring more frequent cleaning. Controlling PM emissions is expected to reduce the adverse health and welfare effects associated with these emissions.

The methodology used to value PM emission reductions is the application of a benefit/Mg value established by the Agency in 1985 for the development of New Source Performance Standards. A policy-based benchmark value of $3,457 (1989 $) was established as an incremental cost-effectiveness cut-off for the development of NSPSs. The establishment of this value suggests that the same value can be used to value PM emission reductions.

Applying the above value to the PM emission reductions, a total benefit value of approximately $37.5 million can be attributed to the EG while a total benefit value of approximately $5.4 million can be attributed to the NSPS.

The approach used in this analysis to monetize the benefits of reduced PM emissions attempts to estimate the average benefit of reducing a Megagram of PM emissions. The estimates represent average values and do not reflect differences in the benefits of achieving the first unit of emission reduction versus the benefits of achieving the last unit of emission reduction. The benefit estimates also ignore the impact of the value of each unit in emission reduction or the geographic placement of the emission reduction.

In addition, the proposed rules are expected to reduce emissions of CO. The EG is expected to reduce baseline CO emissions by approximately 12,800 Mg/yr. The NSPS is expected to reduce CO emissions from new sources by approximately 1,500 Mg/yr. Lack of data prevent further quantification of the benefits associated with these emission reductions.

Table 8-3 presents a summary of the criteria pollutant emission reductions as well as the monetized value of the PM emission reductions.

Table 8-3
Criteria Pollutant Emission Reductions and Benefits
(1989 $)

Pollutant	**Emission Guidelines**		**NSPS**	
	Emission Reduction (Mg/yr)	**Benefits** (million $/yr)	**Emission Reduction** (Mg/yr)	**Benefit** (million $/yr)
PM	10,843.85	37.490	1,565.1	5.411
CO	12,797.31	---	1,545.8	---

9.0 BENEFIT/COST ANALYSIS

This chapter presents a comparison of the costs, emission reductions, and partial benefits associated with the proposed NSPS and EG.

Nationwide total cost estimates for both the NSPS and EG represent costs of control option 5 (DI/FF with carbon) for continuous, intermittent, and batch MWIs. Note that the costs presented in this chapter do not include the costs of controlling pathological MWIs because pathological MWIs will not be regulated under the proposed rules. Likewise, the emission reduction estimates presented in this chapter reflect the same scenario.

Table 9-1 presents the total costs, emission reductions, and quantified PM benefit estimates for the proposed regulations. The NSPS total cost and emission reduction data represent the impacts of new MWIs. The EG total cost and emission reduction data represent the impacts of controlling existing MWIs.

As shown in Table 9-1, the total annual cost of implementing the proposed NSPS is approximately $277 million. The regulation is expected to reduce annual HAP emissions by almost 10,000 Mg, annual criteria pollutant emissions by approximately 3,000 Mg, and annual emissions of dioxins and furans by approximately 22 Kg. The quantified PM health and welfare benefits associated with the NSPS is estimated at approximately $5.4 million annually.

The total annual cost of imposing the proposed EG on existing MWIs is approximately $1.4 billion. Implementation of the EG is expected to achieve a total HAP emission reduction of approximately 40,000 Mg/yr, a total criteria pollutant emission reduction of approximately 24,000 Mg/yr, and a total CDD/CDF emission reduction of approximately 285 Kg/yr. The quantified PM health and welfare benefits expected to result from implementation of the proposed EG is estimated to equal approximately $37.5 million annually.

Due to data paucities, a direct comparison of the costs to the total benefits of the proposed rules is not possible. Therefore, gaps in the data do not allow a conclusion to be reached regarding the efficiency of the proposed rules.

TABLE 9-1
Costs, Emission Reductions, and Quantified Benefits
(1989 $)

	NSPS	EG
Total Annual Cost ($/yr)	$277.3 million	$1.4 billion
Total HAP[a] **Emission Reduction** (Mg/yr)	9,779	40,096
Total Criteria Pollutant[2] **Emission Reduction** (Mg/yr)	3,111	23,641
Total CDD/CDF Emission Reduction (Kg/yr)	22	284
Quantified PM Benefits ($ Million/yr)	$5.4	$37.5

[a] Includes Pb, Cd, HCl, and Hg impacts.

[b] Includes PM and CO impacts.

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16. ABSTRACT

The Regulatory Impact Analysis attempted to compare the costs to the benefits expected to result from the implementation of standards and guidelines. The cost and economic impact discussion is a summary of information from the "Analysis of Economic Impacts" Reports (EPA-453/R-94-047a and EPA-453/R-94-048a). A qualitative discussion of relevant benefit categories such as reduced adverse health and welfare effects is presented. Due to lack of data regarding the benefits associated with reducing specific pollutants, only a few benefit categories were quantified. Therefore, a direct comparison of costs to benefits was not possible. This report is one in a series of reports used as background information in developing air emission standards and guidelines for new and existing medical waste incinerators.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Pollution Control Standards of Performance Emission Guidelines Medical Waste Incinerators	Air Pollution Control Solid Waste Medical Waste Incineration	

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